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EDITOR OF THE MONTH

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REDUCTION OF THE STRENGTH OF MUSCLE CONTRACTION BY APPLICATION OF MOIST HEAT TO THE OVERLYING SKIN *

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The use of hot moist packs in the treatment of various forms of reflex hyperactivity of skeletal muscle, such as the "spasm" of the acute stage of poliomyelitis, is widespread. That hot packs do succeed in reducing the strength of contraction in such conditions is suggested by clinical experience. This is generally regarded as being accomplished by reduction of the activity of the motor nerves. There is, however, another possibility: the hot packs may reflexly decrease the blood supply to the muscles, weaken their contraction strength and so give the impression of relief of "spasm," although bringing about unfavorable metabolic conditions in the muscle. It is the purpose of this paper to show that this possibility is realized under certain specific experimental conditions and to suggest the need for caution in the clinical use of hot packs until it has been shown that this phenomenon does not occur to a significant extent in the muscles of patients subjected to this treatment.

Methods

In these experiments the gastrocnemius muscles of etherized cats were used. The tendon of Achilles was severed from the calcaneus and attached by means of a cord to a writing lever which recorded the contractions on a kymograph. The muscle pulled against a rubber band of sufficient tension to take up the slack in the recording system. To stabilize the origin of the muscle, the condyles of the femur were transfixed with a metal drill which was left in place and held firmly at both ends by clamps attached to the animal board.

In certain experiments contraction of the muscle was evoked by stimulation of the peripheral end of the cut sciatic nerve in midthigh. However, section of this nerve had the disadvantage of severing not only the somatic motor fibers to the muscles but also the afferent fibers from much of the leg and the sympathetic fibers to the gastrocnemius muscle. Accordingly, in most of our experiments, the muscle was excited by stimulation of the peripheral end of the cut seventh lumbar ventral root which had been exposed by laminectomy. This left the afferent and sympathetic paths intact. In all cases single break shocks at a rate of 56 per minute were employed, their intensity being adjusted from time to time to the minimum strength necessary to evoke maximal contractions of the muscle.

The skin overlying the gastrocnemius muscle was shaved at the beginning of the experiment. Woolen packs, dipped in boiling water and passed once through a wringer, were applied to the entire dorsal surface of the leg and covered with oiled silk. The packs were ordinarily left in place for five minute periods.

The temperature of the subcutaneous tissue over the gastrocnemius was measured at frequent intervals by means of a needle thermocouple, inserted through the skin well above the area to be packed and carried down under the skin to the center of that area. In some experiments a second needle thermocouple enabled us to determine the temperature in the depth of the muscle. The thermocouples were attached to direct

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reading Leeds and Northrup potentiometers. Body temperature was measured with a spirit thermometer inserted deeply into the esophagus.

In a number of experiments arterial pressure was measured by a cannula in the carotid artery attached to a mercury manometer.

Procedure

In a typical experiment, after all preparations had been completed, stimulation of the ventral root was begun and contractions recorded until they had become uniform in height and remained so for at least five minutes. Subcutaneous temperatures were recorded every minute.

A hot pack was then applied without interruption of stimulation. Subcutaneous temperatures were recorded as frequently as possible for the first three minutes and at half-minute intervals thereafter. After five minutes the pack was removed, but stimulation and recording continued for at least five minutes.

Results and Comment

A. *Effect of Packing During Sciatic Stimulation.* — Application of a hot moist pack to the skin over the gastrocnemius muscle, caused to contract by stimulation of the peripheral end of the cut sciatic nerve, caused a slight to moderate increase in the strength of contraction, varying (in eight tests in 3 cats) approximately from 5 to 25 per cent of the original height. The deep muscle temperature under these conditions rises about 3.3 degrees centigrade (the average of nine tests on 6 cats, the range being 1.8 to 4.7 degrees). This rise in muscle temperature, acting directly on the muscle fibers [1] and probably also by increasing the blood flow,[2] is doubtless responsible for the increased strength of contraction. Since the sciatic nerve is cut, reflex effects are excluded.

B. *Effect of Packing During Ventral Root Stimulation.* — Application of a hot pack when the gastrocnemius is activated by stimulation of the peripheral end of the cut seventh lumbar ventral root is commonly, although not invariably, followed by a slowly developing reduction of the strength of

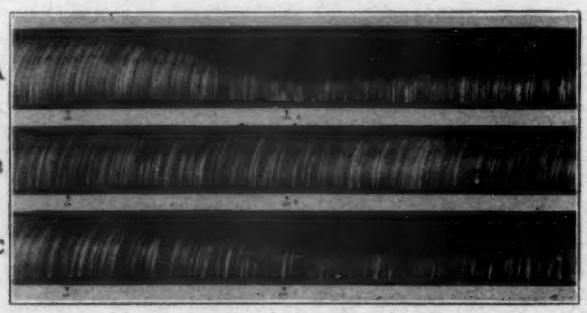

Chart 1. — Effect of hot packs on amplitude of muscle contraction as shown in kymograph records of a typical experiment: *A*, before butesin anesthesia; *B*, during butesin anesthesia; *C*, after recovery from butesin anesthesia.

contraction, which may vary from one which is just discernible to one which lowers the strength of contraction to a level less than half of its prepacking value. A typical example of this effect is shown in chart 1 *A*. The decline may begin within thirty seconds or may not appear until the third minute.

After removal of the pack the strength of contraction gradually increases toward the prepacking level, attaining it in five to fifteen minutes.

The changes in contraction strength minute by minute before, during and following the packing period, are given for a series of experiments in the upper part of table 1.

1. Starling, E. H.: Principals of Human Physiology, Philadelphia, Lea & Febiger, 1926, ed. 4, p. 172.
2. Barcroft, H., and Edholm, E. G.: The Effect of Temperature on Blood Flow and Deep Temperature in the Human Forearm, J. Physiol. 102:5, 1943.

The marked difference in the effect on the strength of muscle contraction of packing when the stimulating current was applied to the ventral root as compared with the sciatic nerve led us to consider what factors might be acting in the former and not in the latter situation. The obvious difference

TABLE 1. — *Effect of Hot Packs on Amplitude of Muscle Contraction as Influenced by Anesthesia of the Skin with Butesin*

The figures in this table give the average and standard error of the mean of the height of contraction as measured on the kymograph record in millimeters.

		Before Packing, Minutes			During Packing, Minutes					After Packing, Minutes		
	No. of Expts.	1	2	3	1	2	3	4	5	1	2	3
Before butesin	13	72.0 ±4.0	71.3 ±3.8	70.3 ±3.9	65.4 ±4.8	61.3 ±5.4	57.8 ±5.1	55.5 ±5.7	52.9 ±6.1	53.2 ±5.9	54.3 ±5.6	56.8 ±4.9
During butesin anesthesia	14	76.0 ±2.7	76.4 ±2.7	75.3 ±2.7	75.8 ±2.3	75.4 ±2.5	74.8 ±2.6	74.8 ±2.7	74.8 ±2.9	74.4 ±2.6	73.2 ±3.0	73.1 ±3.0

is the intactness of (*a*) the afferent paths from the skin and other tissues of the leg to the spinal cord and of (*b*) the sympathetic fibers from the sympathetic trunk to the muscle. We occordingly set up the hypothesis that the hot packs stimulated receptors in some tissue of the leg, so arousing impulses that reflexly activated the sympathetic to the muscle or its blood vessels in such a manner as to decrease its contraction strength. To test this hypothesis the experiments described in the following section were performed.

C. *Effect of Packing During Ventral Root Stimulation with Local Anesthesia of the Skin Over the Gastrocnemius.* — After the conclusion of a test (such as that shown in chart 1 *A*) in which decreased muscle contraction strength had been shown to result from hot pack application, the skin of the shaved area of the dorsal aspect of the leg was painted with a 3 per cent solution of butesin (butyl aminobenzoate) in sesame oil. After five minutes the oil was wiped off and fresh butesin solution applied. This procedure was repeated three consecutive times.

After the last application of butesin, stimulation of the ventral root was resumed, and after due time for the contraction strength to become constant a hot pack was applied. In no case did any clear reduction in strength of contraction appear. A typical example of this is shown in chart 1 *B*, and the results of a series of such experiments are given in table 1. The differences in contraction strength between the values before and during butesin anesthesia are statistically significant, the P values being less than 0.001.

After the elapse of sufficient time (twenty to thirty minutes) for recovery of the skin from the anesthetic effect of butesin, the application of a hot pack again decreased the strength of muscle contraction. An example appears in chart 1 *C*. The averages of a series of tests before, during and after butesin anesthesia are plotted in chart 2.

If during the period in which butesin has prevented the depressive effect of hot packs in the leg to which it has been applied a pack is applied to the untreated opposite leg, decrease in the contraction of its gastrocnemius muscle can be demonstrated. This finding shows that the butesin action is confined to the region to which it is applied and is not systemic.

From these experiments with butesin, it may be concluded that hot packs produce their effect (in the absence of anesthesia of the skin) by stimulation of cutaneous receptors which through some reflex mechanism reduce the strength of muscular contraction.

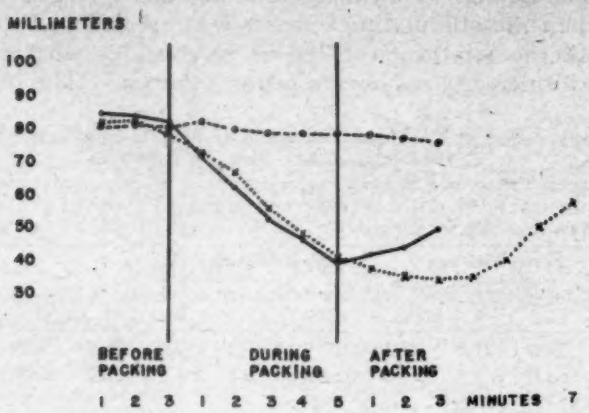

Chart 2. — Amplitude of muscle contraction before, during and after recovery from butesin anesthesia of the skin: an average of three experiments: – – – before butesin anesthesia; — – — during butesin anesthesia; — — — after recovery from butesin anesthesia.

TABLE 2. — *Effect of Hot Packs on Subcutaneous Temperature as Influenced by Skin Anesthesia with Butesin*

The figures represent the average and standard error of the mean of subcutaneous temperature in degrees Centigrade.

		Before Packing, Minutes			During Packing, Minutes					After Packing, Minutes		
	No. of Expts.	1	2	3	1	2	3	4	5	1	2	3
Before butesin	13	.....	34.9 ±.27	45.0 ±1.3	46.3 ±1.2	44.6 ±.80	43.1 ±.63	41.9 ±.60	40.6 ±.59	36.8 ±.41	35.5 ±.25	35.1 ±.22
During butesin anesthesia	13	.....	33.7 ±.42	42.9 ±1.2	44.5 ±.79	43.4 ±.56	41.9 ±.65	40.5 ±.73	39.4 ±.84	36.6 ±.91	35.1 ±.62	34.4 ±.47

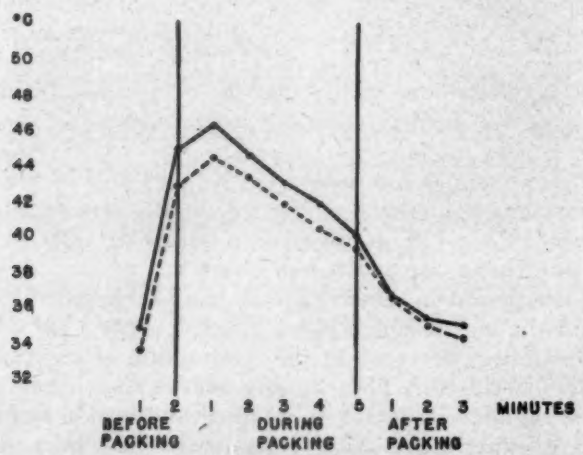

Chart 3. — Effect of hot packs on subcutaneous temperature as influenced by skin anesthesia with butesin: ——— before butesin anesthesia; - - - during butesin anesthesia.

D. *Nature of the Cutaneous Stimulus Evoking This Reflex.* — The subcutaneous temperatures resulting from the application of hot packs are given in table 2 and plotted in chart 3. The temperature rises sharply to a peak about one minute after application of the pack, the rise amounting to about 22 degrees; it then falls slowly by some 11 degrees while the pack remains in place and then more rapidly after removal of the pack.

In order to determine the peak subcutaneous temperature most effective in evoking our reflex, we grouped all the peak values by 2 degree temperature intervals (40 to 42 C., etc.) and averaged the decrease of contraction strength for each such interval. The results, plotted in chart 4, show a maximum effect for the interval of 46 to 48 C., although the reflex can be evoked with lesser intensity by packs yielding subcutaneous temperatures anywhere between 41 and 53 C. The temperature of the skin surface has not been measured but would obviously be considerably above these values.

Whether the receptors involved are those of warmth or pain or both has not been determined. However, since the effective temperatures were

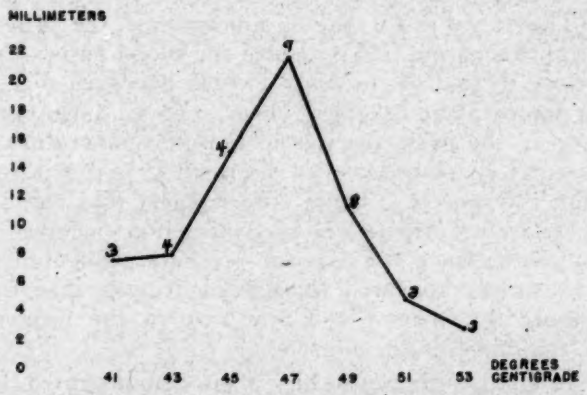

Chart 4. — Relation of the degree of decrease in strength of muscular contraction (vertical axis) to the peak subcutaneous temperature caused by application of hot moist packs (horizontal axis). Figures on the curve represent the number of tests yielding the average which is plotted.

rather high and since moderate rises in arterial pressure (which are often accepted as criteria of pain stimulation) commonly occurred, it seems probable that pain receptor stimulation is involved in evocation of the reflex.

E. *Possible Role of Sympathetic Vasoconstriction in the Reduction of Muscle Strength in This Reflex.* — The question now arises how impulses evoked in afferent nerves by the application of hot packs could affect the central nervous system in such a manner as to reduce the strength of contraction of the muscle. Since the somatic motor fibers have been cut in the ventral root, the only known route whereby, under the conditions of our experiments, such impulses could reach the muscle is through the sympathetic nerves. According to Geohegan and associates,[3] the lowest ventral root carrying preganglionic fibers to the hindlimb of the cat is the third lumbar. Since we have cut only the seventh lumbar, the sympathetic innervation of the gastrocnemius muscle would remain intact.

Several workers have reported that stimulation of the sympathetic trunk during concurrent stimulation of the ventral root evoked sometimes, but not invariably, a decrease in the strength of muscle contraction. Certain of the

3. Geohegan, W. A.; Wolf, G. A., Jr.; Adair, O. J.; Hare, K., and Hinsey, J. C.: The Spinal Origin of the Preganglionic Fibers to the Limbs of the Cat and Monkey, Am. J. Physiol. 135:324, 1942.

published tracings obtained in this manner by Wastl [4] are strikingly similar to those we have obtained by application of hot packs (such as that shown in our chart 1 *A*). Baetjer,[5] using the same technic as Wastl, showed that sympathetic stimulation always caused vasoconstriction in the muscle and attributed the decreased muscular contraction, in those cases in which it occurred, to the consequent reduction in blood flow. Bülbring and Burn,[6] obtaining similar results in perfused dog hindleg preparations stimulated over a ventral root, noted that, while fresh muscles tended to show decreases in contraction strength, fatigued muscles tended to show increases (Orbeli phenomenon).

We have some evidence that in the muscles exhibiting reflex decrease in contraction on application of a hot pack there is a smaller blood flow than when the packs do not evoke the reflex. In six experiments in which the strength of contraction decreased, the deep muscle temperature rise during the packing period averaged 0.05 degree (range, 0.02 to 0.08 degree) per degree rise in subcutaneous temperature, while in seven experiments in which no decrease in contraction occurred the deep muscle temperature rise averaged 0.29 degree (range, 0.07 to 0.51 degree) per degree rise in subcutaneous temperature. (The P value for the significance of the difference between these values is approximately 0.05). Since the blood enters the muscle with a temperature close to that of the body (which averaged 37.7 C.) and, since the deep muscle temperature averaged close to 35 C. during contraction just before application of the pack, the rise in muscle temperature (other factors remaining sufficiently constant, as was the case) is proportional to the blood flow rate through the muscle. These data suggest that the blood flow rate was less when the reflex depression of contraction occurred than when it failed to occur. Now, since the arterial pressure tended to rise more frequently when the reflex appeared than when it was absent, it seems reasonable to attribute the lower blood flow rate in the former case to constriction of the arterioles of the muscle.

A somewhat similar response has been demonstrated by Kuntz and Haselwood,[7] who found that, while application of warm moist packs (45 to 50 C) to the dorsal or lateral abdominal wall of decerebrate cats caused vasodilatation in the stomach and intestines, hot packs (above 52 C). evoked vasoconstriction.

These considerations support the hypothesis previously stated that application of hot moist packs to the skin over the contracting muscle reflexly evokes sympathetic vasoconstriction in the muscle, which reduces local blood flow and so impairs the strength of contraction.

Clinical Application

We wish first to point out clearly that the decrease in muscle contraction resulting from the application of moist heat to the overlying skin has been demonstrated only for the gastrocnemius muscle stimulated over the ventral root in cats under ether anesthesia. It would not be warranted to extend this conclusion to other species, such as man, and to other conditions, such as those of reflex or voluntary activation of muscles, without further investigation. Further, we wish to emphasize that the finding of a decrease in muscle contraction by the reflex which we have described does not imply

4. Wastl, H.: The Effect on Muscle Contraction of Sympathetic Stimulation and of Various Modifications of Conditions, J. Physiol. 60:109, 1925.
5. Baetjer, A. M.: The Relation of the Sympathetic Nervous System to the Contractions and Fatigue of Skeletal Muscle in Mammals, Am. J. Physiol. 93:41, 1930.
6. Bülbring, E., and Burn, J. H.: Blood Flow During Muscle Contraction and the Orbeli Phenomenon in the Dog, J. Physiol. 95:203, 1939.
7. Kuntz, A., and Haselwood, L. A.: Circulatory Reactions in the Gastrointestinal Tract Elicited by Localized Cutaneous Stimulation, Am. Heart J. 20:743, 1940.

that afferent impulses aroused in the skin by hot packs could not reduce the intensity of reflex or voluntary contractions (including spasms and hypertonias of nervous origin) by other mechanisms, such as central inhibition of lower motor neuron discharge.

However, should future work show that the reflex vasoconstriction and consequent decrease in muscular strength can be evoked in significant degree in human muscles by hot packing, certain clinical implications would become important. First, current facile assumptions that application of moist heat always "improves the circulation" in the underlying structures would have to be discarded. Second, the demonstration of increased mobility of joints or decreased resistance of muscles to stretching following this treatment might indicate, not the removal of the cause of the muscle hypertonia, but weakening of the contractile power of the muscles involved.

Third, and most important, in muscles in which spasm or other neurogenic hypertonia is present and which are therefore in constant contraction, a decrease in blood flow caused by hot packing might well reduce the oxygen supply below that necessary for meeting the needs of the increased muscular activity. This might lead to accumulation of metabolites, anoxia, exudation and consequent growth of fibrous tissue, with relatively permanent impairment of muscular function. In other words, treatment with moist heat might lead in conditions such as the acute stage of poliomyelitis with spasm to the development or intensification of the very conditions which it is designed to prevent.

It is this possibility that has led us to publish the results of our experiments, preliminary and incomplete as they are, in the hope that others may be stimulated to investigate the matter further.

Summary

Application of hot moist packs to the skin over the gastrocnemius muscles of etherized cats while contraction was evoked by stimulation of a ventral root often causes a slowly developing reduction in the strength of contraction. Anesthetization of the skin with butesin abolishes this effect. Accordingly, it is concluded that the hot packs stimulate cutaneous receptors which reflexly evoke sympathetic vasoconstriction and reduction in blood flow in the muscle, through which the impairment of contraction strength is brought about. Should a similar reflex effect occur in patients with muscle spasm or hypertonia, treatment with hot moist packs might cause or accentuate unfavorable metabolic conditions in the muscles.

Addendum

Kemp, Paul and Hines (Fed. Proc. 6:141, 1947), have just reported that application of hot packs to the hind limb of dogs reduced the blood flow in the femoral artery, the effect being abolished or lessened by denervation of the limb. These findings support our suggestion that hot packs cause reflex vasoconstriction in the limb; they do not, however, enable us to say whether muscle blood flow is altered in the same manner as the flow to the limb as a whole.

Fuller details of certain aspects of this investigation are available in the theses of Muñoz [8] and of Fitch [9] for the degree of Master of Arts at Stanford University.

8. Muñoz, E.: Immediate Effect of Hot Compresses on Strength of Contraction in Lower Motor Neuron Paralysis, Master of Arts Thesis, Stanford University, June, 1946.
9. Fitch, B. M.: The Effect of Skin Anesthesia on Muscle Contraction Following Application of Hot Packs, Master of Arts Thesis, Stanford University, August, 1947.

We wish to acknowledge with thanks the assistance in many of these experiments of Miss Eleanor Dean, Mrs. W. I. Fox and Mr. Albert Marquez.

THE OPTIMUM REST-EXERCISE BALANCE IN THE TREATMENT OF RHEUMATOID ARTHRITIS *

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PHILADELPHIA

The importance of physical medicine in the treatment of disease and management of convalescence has been sharply emphasized during the past few years. Much of this increased appreciation of the value of physical measures in treatment has resulted from the elaborate Reconditioning Program that was set up by the Army in its hospitals. In this plan physical therapy, occupational therapy and supervised physical training, as well as educational and recreational programs, were coordinated in a way that insured proper convalescent care to all patients.

In the thousands of cases of early and late "chronic infectious" or rheumatoid arthritis treated at the Army Rheumatic Disease Centers, it was found that remissions in the disease occurred at least as quickly on exercise to the limit of individual tolerance as on bed rest, and with a much lower incidence of muscle atrophy and contractures.[1] The gratifying result obtained with treatment consisting mainly of physical measures in this large series of cases justifies the belief that the principles of this plan of treatment can well be adapted to the needs of civilian hospitals and outpatient clinics.

Although drug therapy of rheumatoid arthritis has advanced considerably in the past ten years, no agent is as yet available which can be considered specific for the disease. Even the enthusiasts admit that physical measures are an essential addition to drug therapy in all cases. Although as yet no means are available for halting the "storm," there is much that can be done to help the "ship" weather the blow, so that when that storm finally subsides there will be a minimum of wreckage left to clear.

It is not the purpose of this paper to enter into a detailed discussion of all the modalities of physical therapy that have been found useful in treating arthritis but rather to emphasize the importance of maintaining a proper balance between exercise and rest and to show how to determine the optimum exercise-rest balance for each case, regardless of the severity or stage of the disease.

Bed rest has long been advocated in the treatment of rheumatoid arthritis. In a recent symposium on the abuse of rest, Krusen,[2] stated, "Confusion with regard to the abuse of rest in arthritis is due to the failure to recognize the difference between complete immobilization of the individual and the avoidance of fatigue." He quoted Hench:

> Rest [in arthritis] has been stressed so much that I think we are in danger of over-resting our patients. The dangers of over-rest in arthritis are as great, if not greater, than the dangers of over-exercise. When the patient over-exercises, he promptly knows he has done wrong, because of the increased pain, but when he over-rests, the

* From the Department of Physical Medicine and Arthritis Clinic, Hospital of the University of Pennsylvania.

* Read at the Twenty-Fourth Annual Session of the American Congress of Physical Medicine, New York, Sept. 5, 1946.

1. Hollander, J. L.: Unpublished data.
2. Krusen, F. H.: Discussion on Abuse of Bed Rest, J. A. M. A. 125:1090, 1944.

effects are silent and malicious until one suddenly notes serious, if not irreparable, contractures.

Fixation Versus Mobilization

The conviction that exercise is of importance in maintaining mobility in a joint is by no means new. In 1889 J. Kent Spender,[3] in his classic monograph on rheumatoid arthritis, admonished against immobilization of effected joints and advised continued exercise to prevent atrophy and stiffening.

Much of the disability in patients with rheumatoid arthritis is due not directly to the disease but rather to unskilled physical management during the illness. Most patients date the onset of deformities to a period of restriction to bed or to wearing a plaster cast. Ghormley[4] remarked:

> It is, of course, necessary to use rest in bed in the treatment of arthritis; but I have often thought that the day an arthritic patient gives up and goes to bed is the day he becomes a total cripple. I have been astonished to see patients obviously suffering from severe and disabling arthritis who, by sheer force of circumstances, have been prevented from giving up and going to bed. Such patients usually come through their ordeal with much better joints than do those who have been put to bed, even though the rest in bed may be accompanied by the best available treatment.

Contractures, muscular atrophy and even ankylosis of joints may be prevented by timely consideration of the physiology of the musculoskeletal system and the physical factors involved.[5] Determination and maintainance of the optimum balance between rest and exercise for each patient is one of the most important considerations in the successful treatment of rheumatoid arthritis.

Physiologic Considerations

The mechanism by which exercise preserves maximal joint function is not entirely clear. From the recent discovery of Freund, Steiner and others[6] that the lesions of rheumatoid arthritis are found not only in synovial tissue and bone ends, but also in muscles, fibrous tissues and even nerve sheaths, one knows that the disease is a generalized process.

It is known that the nitrogen balance in a patient confined to bed rapidly becomes negative, regardless of the type or degree of disease, indicating breakdown of tissue.[7] How, then, can one expect a patient with rheumatoid arthritis, a disease known to produce musculoskeletal degeneration, to gain weight and increase muscular strength while lying or sitting motionless week after week? The nitrogen balance studies which show a return to normal balance on resumption of physical activity merely prove chemically what is noted physically—the building up of tissue, mainly muscle.

The continued action of arthritic joints through maximal range of motion prevents formation of adhesions across the joint space and may actually help retard the progression of pannus across the cartilage. It would be difficult to prove that this "wiping-back" of pannus actually occurs, but it would seem consistent that any mechanical deterrence to its spread would also slow up the rate of cartilaginous destruction, even though the proliferative changes in the synovial reflections continue unabated. The motion of a joint through maximum range prevents contraction of the capsular ligaments by a frequent gentle stretching action. This same stretching action on the tendons of the muscles controlling the joint prevents shortening. As far as the muscles themselves are concerned, it is known that disuse produces atrophy and ex-

3. Spender, J. Kent: Rheumatoid Arthritis, London, 1889, p. 40.
4. Ghormley, R. K.: The Abuse of Rest in Bed in Orthopedic Surgery, J. A. M. A. 125:1097, 1944.
5. (*a*) Hench, P. S., and Meyerding, H. W.: The Results of Failure or Neglect in the Care of Chronic Infectious (Atrophic) Arthritis. The Characteristic Deformities and Their Prevention, Med. Clin. N. A. 18:549, 1934. (*b*) Krusen, F. H.: Physical Therapy in Arthritis, J. A. M. A. 115:611, 1940.
6. Freund, H. A.: Steiner, G.; Leichtentritt, B., and Price, A. E.: Science 101:202-203, 1945.
7. (*a*) Cuthbertson, D. P.: The Influence of Prolonged Muscular Rest on the Metabolism, Biochem. J. 23:1328, 1929. (*b*) Grossman, C. M.; Sappington, T. S.; Burrows, B. A.; Lavietes, P. H., and Peters, J. P.; Nitrogen Balance in Acute Infections, J. Clin. Invest. 24:523, 1945.

ercise produces hypertrophy, even when no disease is present.[7a] Disease hastens muscle atrophy and slows regeneration of muscle tissue, but the basic principle is the same here as in normal muscle.

Management of the Bed Patient

Because chronic fatigue is probably a contributing factor in the cause or progression of rheumatoid arthritis, a limited period of bed rest during an acute or severe exacerbation of the disease is often advisable.[5b] This period is the most critical of all and must be as brief as possible.[8] Proper posture must be maintained in bed, omitting the use of pillows under knees or shoulders, with a firm mattress holding up the body without sagging. Physical therapy in the form of local heat and muscle massage or underwater exercises in a Hubbard tank are particularly helpful for a patient confined to bed and should be carried out frequently and faithfully to the limit of the patient's endurance. Muscle-setting exercises are taught and can be carried out by bed patients themselves many times each day, even when movement of a particularly inflamed joint is temporarily contraindicated. Bed exercises of all muscles of the body, when carried out regularly, help prevent the generalized atrophy which so often reaches alarming degrees in the severely ill arthritic patient. All joints, even though acutely inflamed, should be carried gently through the maximum range of motion at least several times daily. This should not be vigorous forcing, but gentle and slow guided motion. Spasm is not produced quickly if the movements are guarded, and a wider range of motion is, therefore, possible.[5b] Corrective exercises should be taught, so that the patients themselves carry out hourly movements and understand that much of the success of the treatment is dependent upon their cooperation. Salicylates are a valuable adjunct in treatment, because the analgesia produced increases the patient's ability to exercise.

The question is often asked: How soon can an arthritic joint be mobilized? We agree with Freyberg[9] that careful movement of an arthritic joint can be carried out at any time except when it produces excruciating pain. If movement of a joint produces severe pain, even after preparation with application of heat and when the movement is attempted slowly and gently, the attempted mobilization should be delayed for a few days and again undertaken.[5a] We have seen few, if any, joints permanently made worse by too early guided mobilization, but have seen all too many permanently deformed because of undue delay in motion. The worst that can be expected from careful early mobilization of even an actively inflamed joint is a little increase in swelling, pain and spasm for a few days.

The Ambulatory Patient

Most patients who have a long-standing rheumatoid arthritis have "learned to live with" their disease and frequently state, "I have found that if I don't keep moving, my joints stiffen up." To these patients the need for continued mobilization is obvious, but in the usual daily routine of activity more than 90 per cent of motion is carried out in a small range about the neutral position.[9] Because of this, contractures may develop insidiously in spite of activity. It is, therefore, often necessary for even the ambulatory arthritic patient to carry each joint through the maximum range of motion more frequently.[5b]

Determination of the Optimum Balance

A preliminary determination of the optimum balance between exercise

8. Dock, Wm.: The Evil Sequelae of Complete Bed Rest, J. A. M. A. 125:1085, 1944.
9. Freyberg, R. H.: The Prevention of Deformities in Rheumatoid Arthritis, address presented before the Philadelphia Rheumatism Society (June 13), 1946.

and rest for a patient suffering from rheumatoid arthritis should be made the first time the patient is seen. The balance is then changed from day to day to fit the condition of the patient. The optimum exercise-rest balance may be defined as the ratio between the *maximum* amount of activity the patient can perform without excessive fatigue, or residual increase of pain or muscle spasm and the *minimum* period of rest needed before the activity can be resumed in the same degree. Thus, a patient may be able to exercise for only five minutes and need an hour rest interval, making his balance 5 to 60, or 1 to 12, whereas another may be able to stand an hour of moderate activity to fifteen minutes of rest, making a ratio of 4 to 1. Naturally, the more strenuous the activity the more quickly fatigue is produced; so the ratio is only applicable to the degree of physical exertion commensurate with the capabilities of the patient. The ratio, therefore, must be qualitative as to type of activity and completeness of rest between, as well as quantitative. In prescribed activity, however, this variable can be eliminated, and day to day increase in the exercise-rest ratio can be used as a quantitative index of improvement.

The following points may be used as steps in establishing the proper exercise-rest balance:

1. The physician in charge of the case should first convince the patient concerning the need for exercise and the dangers of over-rest.
2. The patient should be shown that physical measures are a definite prescribed part of the treatment, just as the drug therapy, and not a mere idea to "keep him busy."
3. General body exercises for uninvolved parts are taught, to be carried out at prescribed intervals, with fatigue as the sign to stop.
4. Local corrective exercises are designed to fit the limitations and needs of the part. Muscle setting, muscle stretching, coordinated muscle action and action through the widest possible range of motion form integral parts of this program. Increasing pain, spasm and fatigue are warning signs of sufficiency.
5. Both general and corrective exercises are repeated at intervals just long enough for the patient to be able to repeat his original amount of exercise, without undue fatigue or increased pain.
6. The well known training principle of gradual increase in amount and duration of exertion is adhered to, remembering also that mild exertion many times a day is easier than exertion to the extreme limit of endurance once or twice.
7. The amount of ambulatory exercise should be in inverse proportion to the degree of activity of arthritis in weight-bearing joints. Even when the process is too acute for weight bearing, however, exercises in bed or a chair may well be carried out to the limits previously noted.
8. Goniometric measurements of the range of motion of diseased joints should be made frequently, thus giving ample warning of beginning contractures or improvement in range of motion.

To illustrate the determination and maintainance of the optimum exercise-rest balance, we cite the following case.

A 64 year old man had increasing joint pain and stiffness for the past fifteen months. He had become moderately anemic, lost 40 pounds in weight and noted severe pain and stiffness in the entire back, including the neck, marked pain and limited motion of both shoulders and swelling, pain and stiffness in the right elbow and wrist and in both knees. He was admitted to the hospital completely bedridden, decidedly emaciated and unable to move about because of pain and spasm in the back, hips, shoulders and knees. Pronounced synovial thickening was noted in the right wrist and elbow and both knees. The wrist retained only about 10 degrees of motion, the elbow lacked 25 degreess of full extension and flexed to 90 degrees. The shoulders

were practically frozen, with marked deltoid muscle atrophy present. The spine and neck were practically fixed; the hips flexed to less than 90 degrees and abducted only 20 degrees. Both knees showed a noticeable flexion deformity, with pronounced atrophy of the quadriceps muscles bilaterally and shortening of the hamstring muscles.

On first glance this man appeared a hopeless cripple. His sedimentation rate was considerably increased, and his temperature showed a daily rise of 100 to 101 F. Roentgenograms showed early changes typical of rheumatoid spondylitis in the sacroiliac joints and vertebral ligaments and pronounced subchondral bone atrophy and soft tissue swelling of the knees, right elbow and wrist and both shoulders.

Previous roentgen therapy to the spine had seemed only to aggravate the process and increase the anemia.

Since the roentgenograms showed no ankylosis in any joint, it was felt that a program of physical measures would be of benefit. The patient was taught the correct rest position in bed and was reassured that exercise would help him. He received daily exercise in the Hubbard tank, and we found that he could exercise slowly for about five minutes each hour without severe pain or tiring. Mild general exercises and corrective local exercises were taught him, to be repeated during his hourly five minute exercise period. Local physical therapy to the right arm and knees was daily added to the therapy in the tank. Constant reassurance and encouragement were necessary to keep the patient interested and cooperative. The pain and swelling of the knees subsided after two weeks, sufficient to permit limited weight bearing, so ambulation in a walking frame was encouraged for a few minutes twice daily, and gradually his ambulation was increased. The patient became quite convinced that the more exercise he could do each day the more he could do the next; consequently carried out his exercises regularly at hourly intervals to the point of tiring. Now, after two months of intensive treatment by physical means alone (with the exception of salicylates), he is almost completely ambulatory, can feed and wash himself, walk for ten to fifteen minutes at a time and perform his exercise standing, and has eliminated the flexion deformities of the knees and right elbow. His shoulders still show limitation of abduction, but improvement in range of motion can be measured weekly. He has gained 5 pounds in weight; his appetite has improved; his sedimentation rate is now only slightly increased, and, above all, he feels much better and more independent. He is still not well, but he now realizes that he can keep himself from becoming an invalid. Now that he has shown so much improvement; we have started gold salt therapy to aid in bringing his disease under control. His exercise-rest balance is now about 2:1 — in other words, he can be up and about for an hour of moderate activity for each half hour of rest in chair or bed.

Practical Considerations

No physician would think of treating pneumococcic pneumonia with a dose of a sulfonamide or penicillin every other day, nor would he expect to control diabetes by using insulin three times weekly, but it is frequently expected that occasional physical therapy and exercise should either produce results or be discontinued as a failure. Obviously the limitations imposed by the shortage of trained personnel and the expense involved makes such frequent treatment almost impossible in many cases, but the time spent by the therapist can be greatly augmented and the expense minimized by making more use of the physical therapist as a teacher rather than simply as a technician to carry out prescribed measures. The patient himself and his attendant, whether a nurse or a member of the family, can be instructed in the methods used, convinced of the necessity for frequent guided activity and warned of the signs of too much exercise. This use of the therapist's time will increase her value many times, and each treatment given by her will be a check on the methods and principles taught on the previous visit, with increases or decreases introduced according to the condition of the patient.

The specialist in physical medicine (or physiatrist) can be invaluable to the clinician in prescribing the proper program of treatment and rehabilitation in each case. All too frequently the practitioner does not realize the importance of a full program of physical measures and simply prescribes "baking and massage" or "diathermy" for a part. Most therapists have been

instructed to carry out such recommendations exactly, thus losing most of the value of treatment by physical means. The physician trained in physical medicine can act as consultant, with much to offer in his knowledge of the broad scope of physical management and its place in the rehabilitation of the arthritic patient. His attention to the details of proper support in bed, gradual increase of activity and ambulation and consideration of the body mechanics covers a part of the treatment program usually forgotten until contractures and deformities have already developed.

Conclusions

1. We feel that treatment by physical means is the most important and most often neglected part of treatment of rheumatoid arthritis. Drug therapy has its place in the therapeutic regimen, and orthopedic surgery is invaluable in correcting late deformities; but the importance of prevention and correction of deformities by appropriate physical means and exercise before they become permanent cannot be overemphasized.

2. Exercise must be carried out frequently by every arthritic patient, regardless of the stage or activity of his disease. The amount and type of exercise must be suited to the degree of disability of the patient. The maximum amount of exercise possible without aggravation of the disease process is counterbalanced by rest periods sufficient to prevent fatigue. This is the optimum exercise-rest balance.

3. Rest has been so overemphasized and exercise so cautiously advocated that the usual result is an over-rested and underexercised patient in whom muscle atrophy and contractures develop. We believe that exercise in the management of arthritis is so important that it deserves additional emphasis. As a patient once aptly put it, when commenting on our regimen, "The exercise is hard, but the rest is easy."

Discussion

Dr. F. H. Ewerhardt (St. Louis): I was much pleased at the opportunity of reviewing the foregoing paper particularly because I have long since incorporated in our physical therapy program for the treatment of arthritis, a balanced schedule of exercise and joint movement. This paper is timely and contains valuable information by which every physician who is called on to treat arthritis could profit. Unfortunately, exercise as and adjunct in the treatment of joint conditions has been much misunderstood, if practiced at all. Probably in many instances the physician discarded or discontinued exercise because it did not prove helpful; the real reason being that it was not done properly. It has long been a moot question how much exercise a patient should be asked to do. Those in the field realize that total rest is just as detrimental as injudicious exercise. Dr. Piersol and Dr. Hollander have presented a plan of a well-balanced exercise program.

In the paper there were brought out some pertinent points which may well be mentioned for emphasis. Some of these points are that many patients date their onset of deformity to the time when complete bed rest was the order or when the joint was put in plaster cast for many weeks. It has been pointed out by A. Keys that "Simple bed rest in the absence of disease or injury produces a variety of metabolic and formal alterations of which many are deleterious and are closely similar to the changes associated with debility, disease or following injury." These observations have been confirmed by others and are now recognized as valid. If this be true of normal persons, it does not take much cerebration to conclude how much damage may be done in cases of disease. Others have pointed out that rheumatoid arthritis is not only a joint condition but the pathology infiltrates the soft tissues as well. This is an added reason for instituting physical measures to improve circulation.

The matter of joint motion is mentioned in this paper. Stress is put on the importance of carrying movement through as complete a range of motion as conditions may permit, the restricting factor being excruiting pain. It is mentioned that joint motion prevents contraction of the capsule, ligaments and muscle shortening. If I may be permitted, I wish to add that it retains proprioception, which is an important factor in the matter of balance and gait. Dr. Piersol mentions muscle setting exercise and general body bed exercises. Because the exercise is non-weight bearing, the patient not only can, but is usually very willing to carry out a certain number of movements, perhaps

for every waking hour of the day. We frequently place the lower extremities in an elastic over-head suspension so adjusted as to elevate the heel two or three inches off the bed sheet. This not only relieves pressure on the gastrocnemious group, thus interfering with circulation, but also allows a greater range of voluntary movements with weight bearing practically eliminated. Opponents of the exercise theory state that exercise and joint motion cause irritation of the joint and therefore increase pain and disability. This may be true if the program is not well guided. Dr. Piersol states that if on the following day pain has increased, it is an indication that the program probably was a little too strenuous and should be eased up. It is conceded that joint motion will cause pain but if the treatment is well-guarded the increase is not deleterious. I agree thoroughly with the authors when they state, "We have seen few, if any, joints permanently made worse by too early guided mobilization, but have seen all too many permanently deformed because of undue delay in motion."

Dr. **Robert M. Stecher** (Cleveland): There is wide variation in the recommendations as to therapeutic exercise. We heard a paper this morning which described definite discoverable chemical changes in blood returning from an extremity following one to three minutes of mild exercise. Another paper recommended electrical stimulation of individual muscles producing contractures to the number of 3600 to 4000 times in a single treatment.

The only reliable means for deciding this question is by observation of the patient and by being guided by the response which takes place. I think that exercise should be continued to the limit of tolerance but avoiding undue fatigue or irritation. Any further discussion on my part would only repeat what the essayists have said.

AN ANALYSIS OF CERTAIN PROCEDURES EMPLOYED IN THE PHYSICAL MEDICINE TREATMENT OF AMPUTATIONS *

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In the observation in the military service of over 2,000 amputees for whom physical therapy in some form was requested, we have gained considerable information relative to the proper sphere of physical medicine in the general management of the amputation problem. As a result of the overall experience gained in the military service, undoubtedly greater attention will be focused on physical medicine procedures in the management of civilian amputees. There should be wide applicability of such knowledge, since a recent report of the Baruch Committee on Physical Medicine[1] indicates that major amputations from injury or disease in civil life occur at the approximate rate of 24,000 cases annually.

Bandaging of the stump, therapeutic exercises and training in the use of the lower extremity prosthesis are universally employed procedures which fall within the scope of physical medicine. With few exceptions,[2] the literature is largely barren of definitive information regarding these procedures, and physicians and physical therapists alike frequently have no clear concept of their proper use. In the hope that our observations and comments

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1. Baruch Committee on Physical Medicine: Report on a Community Rehabilitation Service and Center (Functional Plan), New York, 1946.
2. Dow, R. F.: Treatment of Military Amputees, Arch. Phys. Med. 26:139, 1945. Brunnstrom, Signe: Physical Therapy in After Care of Amputations of Lower Extremity, U. S. Nav. Med. Bull. 43: 634, 1944.

may help clarify this situation, we present a candid discussion of certain errors which have arisen in the administration of physical therapy procedures. No attempt will be made to pick minor flaws in technics or to discuss debatable procedures in this discussion.

Bandaging of the Stump

We believe that bandaging may accomplish two things: (1) support the tissues of the stump during ambulation and (2) aid in the process of shrinking of the stump during the late postoperative period in order to render more satisfactory its subsequent fit to the bucket of the prosthesis. (Omitted from this discussion is its role following surgical revision of the stump as a compressing agent in the control of hematoma formation.) These accomplishments do not coincide. Each has its proper sphere and must be confined to that sphere if the desired aim is to be achieved. Before we present what we believe to be the proper employment of the bandage, certain errors encountered in its use will be discussed.

The commonest error is that the bandage is applied without consideration of its proper function at a given stage in the patient's treatment. The gravest errors have resulted from the well intended but totally erroneous concept that each application of the bandage should attempt to shrink the stump, regardless of whether or not shrinking of the stump is indicated or, for that matter, whether shrinking can be accomplished by bandaging alone. Snug application of the bandage before approximately four to six weeks following surgical revision of the stump is very likely to result in one or more of the following occurrences:

1. Healing will be delayed by reason of undue superficial soft tissue compression.
2. An odd-shaped stump will be produced, which will be difficult to fit with a prosthesis bucket.
3. A dimple or crease will form on the distal end of the stump. Through ischemic fibrosis this becomes adherent to the bone end and its overlying subcutaneous tissue. Clinically this is marked by an annoying chain of symptoms and complaints which have pain as their common denominator.
4. An ischemic ulceration of the skin or traumatic periostitis of the bone may develop from undue compression by the bandage, either at chance locations or at certain sites of predilection, such as the crest and tubercle of the tibia and the head of the fibula.

Sinus tract formation may develop. It is not intended to imply that bandaging is the causative agent of sinus tract formation. However, we do feel that undue pressure over unhealed or unstable soft tissue planes which may harbor micro-organisms of low virulence provides a favorable nidus for the development of a sinus. Certainly the fact that mere removal of the bandage and placing the patient at bed rest may result in rapid obliteration of such a tract lends credence to this belief.

Each of these untoward results is regrettable not only because of the harm done to the stump but also because of the fact that in the vast majority of instances it is preventable.

The second group of errors relate to the technic of bandaging:

1. The first technical error arises from the effort to make the bandage look neat. When the bandage is applied over the distal surface of the stump, undue tension is often exerted in order to prevent "dogears." On removal of the bandage, if its tension has been sufficiently great, its borders may be marked on the skin by a reddened line, frequently dotted with punctate hemorrhages, caused by the selvage which is firmer and less elastic than is the body of

the bandage. The area between these linear marks is edematous.

2. The second violation of proper technic is in the application of the spirals of the bandage in a circular fashion. This tendency is particularly pronounced toward the proximal portion of the stump. It is self evident that a circular bandage turn will exert a tourniquet effect when it is under any considerable tension. The nearer the proximal portion of the stump, the narrower the spirals tend to become, the more tightly the bandage is applied in order to be anchored and the greater is this tourniquet effect. The result of bandaging in this fashion is edema of the distal portion of the stump. It should always be borne in mind that the spirals must be applied obliquely if this blocking effect on the circulation is to be minimized.

3. The third technical error concerns the "covering-up" effect of too many bandages. Not infrequently thigh stumps have been noted to be covered with a layer of bandages a quarter of an inch in thickness. What lies beneath the outermost layer of the bandage can only be guessed at. It is usually impossible to detect technical errors in the application of such a bandage; the subsequent discovery of the results of improper bandaging should, therefore, be no surprise.

4. We believe it is an error to entrust the procedure of bandaging to the hands of the inexpert. It has been directed[3] that patients be taught to bandage their own stump (although it is not possible for those with an above-knee amputation to do so). The spectacle of bandages held on by adhesive tape or by looping the free end through the trousers belt would be amusing were it not for the realization that this is supposed to be a therapeutic procedure. It is our conviction that proper bandaging is a procedure to be administered by skilled hands only. Even careful, expert inspection of a bandage applied by the inexpert does not insure its proper application. If bandaging is to be employed, it must be done properly.

5. The final error concerns the application of the same bandage to the stump many times. We have repeatedly removed bandages in which not the slightest residual of elasticity could be demonstrated. Since the usefulness of the bandage revolves around its elastic properties, it is difficult to conceive that any therapeutic purpose is being served by the application of these worn-out or stretched-out bandages.

When the bandage is to be applied for purposes of support, the following comments apply: During the time the stump is unhealed and for the first four to six weeks following revision of the stump, or for an equal period of time after primary amputation, the bandage should be applied only for support of the soft tissues during ambulation or to hold an indicated dressing in place. When the bandage is so applied, these questions are pertinent:

1. When is the bandage to be worn? If the patient is to be up for any period of time, the bandage should be applied before he gets out of bed. On his return to bed, the bandage is to be removed. If the stump is unhealed, a simple gauze bandage, with or without medication, is applied.

2. Under how much tension is the bandage applied? It should be applied under slight tension, an amount just sufficient to prevent the bandage from wrinkling as it is applied. If this gentle support seems tight to the patient, the problem should be solved, not by further loosening of the bandage, but by its removal and by restriction of the patient's ambulation.

3. How frequently is the bandage to be changed? It should be reapplied every time the patient is to be out of bed and should be removed when he returns to bed.

4. Are there supplementary measures which should be employed con-

3. U. S. War Department Technical Bulletin, TB MED 122, Physical Therapy for Amputees, Washington, D. C., 1944.

currently with bandaging? Yes, one valuable measure is the regular employment of Buerger exercises[4] during this period. These exercises are to be done several times daily, and one should be sure that each period of ambulation is followed by such exercise. Other measures helpful in healing the open stump are not to be neglected during this time.

When the bandage is to aid the process of shrinking of the soft tissue of the stump, the following comments apply: Beginning about ten days or two weeks before the bucket of the prosthesis is to be fitted, the bandage may be applied more snugly and under greater tension than previously. In considering this problem, two facts should be kept in mind: Healthy tissue does not swell, and the bandage cannot squeeze fluid or fat cells out of the stump. Shrinking of the stump, then, becomes a problem of improving the circulation within the stump, the preventing of swelling of the soft tissues and the restoration of the normal tensile strength of the connective tissue of the stump. The role of the bandage in shrinking is limited to the prevention of swelling. This would imply that the bandage is to be applied under moderate tension snugly to the stump at the time when rest and recumbency have reduced soft tissue swelling to a minimum. This bandage is left on for not more than two to three hours, or less if it feels uncomfortably tight to the patient. It is removed for the same reason that a tourniquet is loosened periodically—to permit reestablishment of the circulation. While the bandage is removed the patient should be recumbent. Provided that there is no medical reason to the contrary, the stump may then be massaged or "rubbed" briefly by the patient, modified Buerger exercises may be performed or other measures may be employed which will facilitate improvement in circulation of the stump. After these procedures the stump should again be bandaged with a fresh Ace bandage for the same length of time as previously. This cycle may be repeated four to five times daily, the bandage always being worn whenever the patient is ambulatory. It should be removed at night. This regimen will accelerate shrinking faster than will Nature alone. When the stump has reached the optimum shape, modified Buerger exercises following initially short but increasingly longer periods of ambulation without Ace bandage support may be instituted to restore the normal elastic tone to the soft tissues.

Therapeutic Exercise

Many, indeed, are the errors which are committed under the camouflage of therapeutic exercise. Muscular action is, without doubt, exercise, but that it is at the same time therapeutic is not necessarily true.

It is commonly believed that there is a consistent pattern of muscular weaknesses associated with amputations of the lower extremity. Weakness of the hip extensors, adductors and internal rotators and weakness of the knee extensors are the defects usually stated to occur.[5] Treatment of these weaknesses has been directed toward exercise of these muscle groups. In consequence, the patient has been instructed in the performance of a routine series of exercises which often fall far short of their intended purpose. In searching for the reasons for these therapeutic failures, several defects have occurred so consistently that it seems pertinent to comment on them:

1. Exercises are done without accurate information as to their true need in the given patient and are continued beyond the time when the indication for them has vanished.

2. Exercises are given without regard for proper dosage, except for the

4. Buerger, L.: Cited by Bierman, W.: Physical Medicine in General Practice, New York, Paul B. Hoeber, Inc., 1944, pp. 497-498.

5. Kirk, N. T.: Amputations, in Lewis' Practice of Surgery, Hagerstown, Md. W. F. Prior Company, Inc., 1943, vol. 3, chap. 10, pp. 133-135.

far-fetched generality that the weaker the muscle the more exercise it needs. In consequence, we have seen patients grimly endeavoring to complete the two or three hour exercise period that has been prescribed, although long before this time had elapsed he was using every possible muscle substitution in an unconscious effort to spare the weak, and by then totally fatigued, muscle.

3. Exercises often are prescribed solely on a routine basis. This follows the line of reasoning that if the majority of patients show a given muscle weakness it should be good practice to administer the same corrective exercises to all patients; at least, according to this reasoning, it will not do the patient any harm.

4. Much too frequently undue responsibility is placed on the patient to carry out his own exercises, without adequate instruction and supervision, with the result that they are done in a desulatory fashion which certainly does not justify the name of therapeutic exercise.

5. Much of an adequate therapeutic exercise program may be undone by an ill advised series of exercises which the patient often devises for himself, gets from physical culture magazines or procures from other sources.

It seems only fair to restrict the term "therapeutic exercises" to those exercises which are properly designed to correct a known defect. They are begun as soon as medically feasible after the diagnosis of the defect and are discontinued with the disappearance of the defect. They are dosed and spaced in accordance with the patient's response, and proper care is taken to insure that accessory factors do not militate against their proper action. In short, therapeutic exercises should be much the same as any other therapeutic procedure.

In accordance with this concept, we believe that the first requisite to the proper prescription of exercise is an accurate knowledge of the body mechanics of the patient. This involves checking for postural alinement, tests for flexibility, extensibility and contractures and tests of the principle muscles and muscle groups concerned in postural mechanics.[6] When one is in possession of this information, the initial therapeutic exercise prescription may be formulated. This may appear to be a formidable procedure. Actually, the half-hour spent in compiling these data may save many man hours on the part of others in the department who must administer and supervise the exercises. Repetition of this examination will serve to check on the progress of the patient and will determine whether the exercises should be continued or discontinued.

Once the necessity for a given exercise is established, the manner of performance of that exercise becomes the next problem. We believe that a specific exercise to be therapeutic must be done but one way; there are not multiple correct ways of doing the same exercise to obtain therapeutic results in any given set of conditions. For this reason, particular attention is paid to the instruction of the patient, in order to be sure that he understands not only why the exercise is to be done but also how it is to be done; individual supervision of the exercise is provided until its perfect performance is assured. As a point in illustration, hip extension exercises of the stump side are commonly needed. Unless measures are taken to insure stabilization of the pelvis in order that the extension of the thigh will be true motion at the axis of the hip joint, the movement will be one of anterior pelvic tilt with hyperextension of the lumbar spine and will result in exercise of the lower erector spinae group, not of the hip extensors. Again, with the same illustration of hip extensor exercise, such exercise will be largely bar-

6. U. S. War Department Technical Manual, TM 8-293, Physical-Therapy for Lower Extremity Amputees, Washington, D. C., June, 1946.

ren of results, even if performed correctly by proper fixation of the pelvis and proper position of the patient, in the presence of contracture of the hip flexors. The proper sequence should be to precede the corrective exercise with stretching of the contracture. The final illustration concerns exercise of the gluteus medius muscle. As a general statement, the gluteus medius of the stump side is almost never weak; the gluteus medius of the opposite leg in the ambulant person is almost always weak by reason of the constant strain and stretch to which it is subject in weight bearing. If the ambulatory activities of the patient are sufficient to weaken such a muscle, prescribed exercise, in addition to these activities, cannot but further fatigue that muscle. However, if such exercise is begun on the nonambulant patient at a time when the gluteus medius is at rest mechanically, it may easily be strengthened to the point that it will not weaken significantly upon subsequent weight bearing. One amputee, in our experience, was able to hop more than a mile on his one leg; obviously this could not be done with a weak gluteus medius.

The basic principles of therapeutic exercise for the amputee in our opinion are:

1. An accurate knowledge of specific muscle weakness and contracture based on muscle and postural examinations.
2. Proper exercise positions.
3. Proper instruction in and supervision of the exercises.
4. Avoidance of other exercises involving antagonists of these weak muscles until muscle balance has been restored.
5. Discontinuance of the specific exercises when need for them disappears. General body building exercises may then be instituted as indicated.
6. Insistence on the proper use of the formerly weakened muscles following restoration of muscle balance.

Training in the Use of the Lower Extremity Prosthesis

Mistakes and failures have generously littered this portion of the therapeutic pathway. Many of these errors are not chargeable to physical therapy, but, since this field is so closely concerned with these problems, it is well to be completely aware of them.

1. Almost without exception, the initial reaction of the patient to his new prosthesis is one of disappointment. His dream of a postwar prosthesis which was to have been the perfect replacement for his missing extremity is rudely dispelled when he finds that the prosthesis of reality has many faults in appearance as well as in use. His spirits sink lower and lower as he contemplates a future dependent on this contrivance. In consequence, his initial effort to learn the use of the prosthesis is usually not his best effort. It requires a great deal of patience and understanding on the part of all concerned to help the patient over this initial hurdle.

2. Once the prosthesis is accepted, the patient often practices walking or whiles away long hours on his feet the first day or the first few days after he receives the prosthesis. The swollen, painful stump which develops subsequently serves as adequate reminder, if such be needed, that the prosthesis may not be worn with impunity. Those of us who have seen patients "grounded" for many days and even come to reamputation because of this excessive initial use of the prosthesis are, with good reason, conservative in this stage and restrict the initial wearing of the prosthesis to brief periods only.

3. Patients rarely are content to acquire facility in the use of the prosthesis one step at a time. This applies particularly to the patient with an

above-knee amputation who finds it difficult to resign himself to an extended course of learning to use his prosthesis. One result of such eagerness and impatience is the patient's attempt to perform certain feats with the prosthesis far in advance of his ability. The proper grounding in the fundamentals of walking are an absolute preliminary to such feats. In the military service, these attempts by patients have especially followed visits and demonstrations by skilled amputees. The inspiration and sometimes the encouragement of these skilled amputees have promoted competition to achieve goals which should not yet be attempted. The unsuccessful struggle for such achievement often convinces the amputee that it is useless to continue the learning process, since he will not be able to perform the skilled acts anyway. The occasional successful achievement may convince the amputee that the graded process of learning is not necessary. We have failed to find many short cuts in the achievement of efficient use of the prosthesis; the early attempt to perform such skilled acts is not one of the short cuts.

4. The skilled amputee himself occasionally has created a problem by directly or indirectly diminishing the confidence of the patient in the ability of his instructor. The expressed or implied conclusion that an instructor is not really qualified to teach walking because he or she has all extremities intact unfortunately seems logical to many patients. The result is that established walking fundamentals may be cast aside for the apparent logic of another amputee's instructions.

5. Adjustments in the prosthesis occasionally lag far behind the need for them. Two undesirable features attend neglect of prosthesis adjustments: Either the patient will learn improper walking habits, or he will fail to gain proficiency at the rate which might reasonably be expected. Improper walking habits are learned very quickly if the prosthesis is uncomfortable or causes pain when worn. The causes for such discomfort or pain must be speedily sought out and corrected. This presupposes close liaison among the orthopedic mechanic, the orthopedic surgeon and the physiatrist. Among patients who are obviously trying to learn, failure to acquire facility in the use of the prosthesis is most frequently seen when the prosthesis is initially fitted in a position of hip flexion by reason of hip flexion contracture. As the contracture is stretched out, the fit of the prosthesis must be adjusted; otherwise the patient is held in the initial position of hip flexion.

6. Finally, there too often is a failure to understand what actually can be accomplished by the program of training in the use of the prosthesis. A program will fail which has as its purpose the complete education of the amputee in using his prosthesis; it attempts too much. A program will also fail which is too simplified; the patient misses the fundamentals on which walking skill is founded. We believe that the ultimate success or failure in the use of the prosthesis rests with the amputee himself. All anyone can hope to accomplish as an instructor is to ground the patient thoroughly in the fundamental principles of the use of the prosthesis.

Conclusion

In conclusion, we wish to emphasize that physical medicine shoulders a large share of the responsibility of the management of the amputee. This field can prove its worth best by careful application of experience-proved procedures. Even in the employment of such procedures, constant care is necessary to guard against the introduction of factors which interfere with the usefulness of these procedures. Above all, technics must be examined frequently for errors of commission and omission. One learns more from identification and correction of these errors than from an unbroken chain of therapeutic successes.

Discussion

Dr. Robert F. Dow (Bethesda, Md.): As Dr. Rose has so correctly intimated, the problem of rehabilitation of amputees is a relatively prevalent one and one in which attention must be directed to the smallest details of management.

As to the prevalence of this disability, for contrast I should like to make reference to the incidence of reported poliomyelitis as indicated in the study by Paul H. Harmon (Harmon, Paul H., The Geographical and Racial Incidence of Poliomyelitis, Int. Bull. A40: pp. 136-151; 1939/1940.) For the period of sixteen years from 1919 to 1934, inclusive, the incidence of poliomyelitis in the United States and Canada combined was an annual average of approximately six thousand cases. This figure equals only one-quarter the estimated annual peace-time incidence of new amputations (twenty-four thousand). In this same period of sixteen years, the average incidence was exceeded only four times (1927, 1930, 1931, 1934). In only one of these years did the figures for poliomyelitis for the systematically reporting world (i. e., United States and Canada, Germany, England, Scandinavia, France, Central European countries, Italy, Spain, Finland and the Balkan States, Australia and New Zealand) exceed the recent average annual civilian rates for major amputations in the United States alone. In three other years (1927, 1930, 1934), the "world" reports for poliomyelitis were equal roughly to 75 per cent of this country's amputation average; in 1932, roughly to 60 per cent; and in the other eleven years did not exceed 50 per cent. Of course, in view of presently improved diagnoses and reporting methods, these figures probably are grossly incorrect; reports on amputations are similarly incomplete, however.

The physiatric approach to the amputee has as its goal, aside from insuring employability and providing social adjustment, the efficient use of the prosthesis; all procedures must be coordinated toward the achievement of this single goal.

I do not find it possible to agree with all the points Dr. Rose has made in this generally excellent essay; I am in disagreement with some of his deductions, especially the one concerning the etiology of dimpling in the stump-face scar and also with the statement that early bandaging delays healing. On this latter point, it must be stated that it was our practice to employ bandaging throughout the postoperative period; this bandaging was done largely by physical therapy personnel and begun from the fourteenth to sixteenth postoperative day, at which time the patient became the almost complete responsibility of the department of physical medicine and /or the limb-fitter. In a case experience which is believed to have exceeded the large series of cases observed by the essayist, it was common practice for the patients having below the knee amputations to look forward to prosthesis-fitting after four to six weeks of physical therapy applications (i. e., six to eight weeks following the last surgery). Surely, this relatively early fitting date does not indicate that early bandaging, provided it is properly applied, interferes with healing. Of course, improper (i. e., circulatory-arresting) bandaging may interfere with healing or produce ischemic complications during any stage of recovery. Similarly, it is not our experience that an odd-shaped stump ensues as a result of early bandaging; rather this tends to occur from an improperly applied bandage which exerts uneven compression. Thus, it is the "poor" bandage and not the "early" one which causes the trouble.

Moreover, I do not believe that early bandaging will cause a dimple or crease, nor that ischemic fibrosis is the proper explanation for later adherence of the scar to the bone face. Dimpling and creasing may be minimized if an even side-to-side pressure is used in the bandage recurrents as they pass over the scar. Then, too, it was our practice to mobilize the scar beginning two weeks after surgery, by the use of friction massage; the entire stump was not massaged, but attention was paid largely to the scar and the immediately surrounding tissues. Thus, I do not believe that improper bandaging causes the formation of an adherent scar; however, it may facilitate it by increasing the immobility of the tissues during that period when organization of the exudate occurs beneath the suture line. Ischemic ulceration from undue compression undoubtedly occurs, but I never saw an instance of it.

The authors have made some excellent points concerning precautions to be employed in bandaging during the molding period. Concerning the covering-up effect of too many bandages, I do not believe we need to worry too much about how thick the bandages are nor what is underneath, provided that we utilize expert, reliable personnel, adequately trained in correct principles of amputee bandaging. Incidentally, I do believe that the physical therapy technician and not the nurse should do the bandaging, provided it is administratively possible to provide such service with sufficient frequency during the day, until such time as the patient may care for his own stump.

I was very interested in hearing the essayists' discussion on utilization of Buerger exercises. Circulatory deficiency in the revised stump was present in only a minor percentage of our cases, a variation from the experience of the authors which may be ascribed possibly to minor differences in surgical management.

The statement was made that the bandage should be removed at night and that acceleration through shrinkage will occur if this is done. I should like to ask whether a controlled study has been undertaken which compared shrinkage in the patients with the bandage off at night and in others where the bandage was applied constantly.

To the items previously mentioned as

being undertaken in the initial physiatric examination, I should like to add the measurement of limb girth in comparison with the unaffected side, and a note on the condition of the scar and skin of the stump.

I should like to reemphasize the point that has been made concerning the necessity of specific remedial exercise, general body exercise and particularly attention for the non-affected lower extremity including a foot exercise regimen. This should be undertaken as soon as the patient is seen because of the great tendency of unilateral amputees, during the preprosthetic period, at least, to hop around on one foot despite the fact that it should be routine to advise them against this traumatic practice.

Probably the best advice that can be given to anyone intending to provide prosthetic walking instruction is that the patient should be garbed only in bathing trunks, socks and shoes, so that all walking errors may be more easily seen and corrected. Depression in the patient will be directly proportionate to the interest exhibited by attending medical personnel in the patient's entire problem. Attention must be paid to providing psycho-social adjustment, to developing employability by vocational conversion if necessary, and to instituting general body correction, as well as to the needs of his stump. No longer is it permissible to forget about the patient once the suture line is healed. Depression will be lessened if there are fellow patients who are more advanced and walk well (or if there are movies of such patients) to encourage the recently amputated. It is absolutely necessary that the patient come directly from the limb-fitter to the physical therapy department carrying his prosthesis in his hand so that he will learn no objectionable walking habits before the technician has had the opportunity to teach him such fundamental things as balance, etc. It must be emphasized that the discussion has centered around a training program: "Training" always connotes a graduated and sometimes tedious process. The keynote for the patient, therefore, is conservative but progressive participation.

Liaison with limb-fitters is a more difficult problem to arrange in the civilian than in the military hospital. However, personal experience since the war's termination indicates that the limb-fitters may be very interested in jointly assaying the needs of the patient in conference with the physical therapy personnel; in fact, the extent of their willingness to cooperate and collaborate in this respect may surprise some.

While training programs may grow to become either excessive or deficient, it is definitely advisable to work out an advance plan of therapy in order to avoid haphazard management of the patient. The slogan for management of the amputee should be: "Assay his defects, obtain prosthetic adjustment whenever it is indicated even in a minor degree, correct anything that will interfere with walking and proper postural alinement, and be interested in HIM as well as in his stump."

Dr. Edward W. Lowman (Philadelphia): Dr. Rose has excellently surveyed the physiatric pitfalls in the rehabilitation of the amputee.

His critical appraisal of the indications and methods of application of shrinkers is most important. The proper preparation of a stump for prosthesis is premised on the proper use of elastic shrinkers.

It has been our experience, however, that below knee amputees can readily be taught the technic for applying shrinkers. It is necessary that frequent stump checks be made to ensure the correct application of shrinkers and the intelligent cooperation of the patient. Indifference, negligence, or ignorance results in a poorly prepared stump. One patient, for example, in my experience, because of a persistent indifference toward the proper use of his shrinkers obtained little reduction in the size of his stump in the preprosthetic stage. Following the shrinkage which resulted from walking in his bucket, he ultimately required five stump socks which, of course, necessitated a complete reconstruction of his prosthesis and considerable prolongation of his rehabilitation period.

With the above knee amputee, rarely is it true that he is capable of adequately applying his shrinker. In the case of the latter, especially if the above knee amputation is high, it is impossible for him to adequately wrap a spica type of bandage; where a simple spiral thigh bandage is resorted to, the spirals are not carried sufficiently high by the patient and there remains a pendulous ring of tissue between the ischial tuberosity and the superior margin of the shrinker. This obviously results in inadequate and disproportionate shrinkage which renders prosthesis application unsatisfactory. For the above knee amputee, then, the wrapping of shrinkers must be done by either a technician or by another amputeee.

Therapeutic exercise should have its roots deeply imbedded in the amputee's program. It should be initiated early as a prophylactic measure. Insistence on good bed posture for the newly postoperative and the early introduction of extension-adduction exercises for the above knee and quadriceps exercises for the below knee are most helpful in the prevention of the flexion-abduction contractures of hips and the flexion contractures of knees which too frequently are seen as late and difficult corrective problems.

In all convalescent above knee amputees, unilateral and especially bilateral, there is a great predisposition towards the development of postural abduction-external rotational contractures of hips as a consequence of prolonged dependence upon wheelchairs in which the maintenance of equilibrium demands this abnormal stump position. It is of value in these cases to initiate prophylactic therapeutic exercise early and to maintain it until the prosthesis stage.

For all patients an intensive prepros-

thetic conditioning exercise period of four to six weeks is a great boost in building additional strength for the more expeditious accomplishment of dexterity in the use of their prostheses.

As implied by Dr. Rose, the usual modalities of physical medicine are infrequently indicated for the amputee. For the ulcerated stump, daily whirlpool baths followed by the local application of ultraviolet light are of value in speeding healing. For the adherent scar, massage often can be of benefit, but it must be utilized early before firm fibrotic adherence has ensued if the best results are to be expected.

With civilian medical attention now focused acutely on the rehabilitation of disabled, the successes and mistakes of the service and the observations today of Dr. Rose culled from his extensive experience with Army amputees should ensure sound principles for the inauguration of effective civilian amputee programs.

Dr. Donald Rose (closing): Dr. Dow's question cannot be answered in terms of statistics which will withstand critical appraisal. Two groups of patients were observed, one group having the amputation stump bandaged at night, the other having the bandage removed at night. The conclusion, shared by the orthopedic section at large, was that the stump which was unbandaged at night exhibited an improved tonus of the skin and soft tissue in general. This was attributed to the mildly stimulating effect on the circulation of the normal bed activities, an effect otherwise obliterated by the bandage.

While it was not possible to reduce the term "improvement" to a numerical figure, the acceleration of healing and the improvement in tensile strength of the connective tissue of the stump are factors which contribute to the earlier satisfactory fit of the bucket of the prosthesis and indirectly to the satisfactory use of the prosthesis itself.

REHABILITATION IN INDUSTRIAL MEDICINE *

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With the extension of modern rehabilitation facilities came the realization that physical measures must, to be effective, be applied early. In many instances they may be started with advantage as soon as the patient arrives in a hospital bed. In general, it can be stated that, if there are no indications to the contrary, the earlier this rehabilitation treatment is begun the better. Thus, for example, a patient who is admitted for operation for an internal derangement of the knee may often benefit from a preoperational course to strengthen the quadriceps muscles; while a person with a lower leg in plaster ought to begin weight-bearing exercises as soon as he is ambulatory. Rehabilitation in the full sense of the word cannot be separated from surgical treatment. The best results following an injury are obtained only when first class surgical treatment is followed by first class physical procedures. Needless to say, any doctor can prescribe the treatment, but, owing to an unfortunate blank in the medical curriculum, he is often unable to do so. Specialized medical supervision of these activities is essential to the complete efficiency of rehabilitation to ensure the correct application of all the methods and physical agents used, and, of even more urgent importance, to hold the proper balance between activity and rest in varying stages of recovery. In addition, well trained physical therapists and occupational therapists are equally essential to carry out intelligently the prescription of the physician; and, while not trained medically, these members of the team are fully qualified technically.

* An address given before the Industrial Physicians' Club, Detroit, November, 1946.

Physical medicine should prove of great value in the treatment of fractures. In "An Outline of the Treatment of Fractures," by the American College of Surgeons, the section on the healing of fractures gives many reasons for the use of physical medicine. In this outline it is stated:

> Within a few hours of the fracture, fibroblasts appear in the fibrin clot and begin the formation of granulation tissue. The organization of granulation tissue proceeds in the fibrin mesh throughout the affected soft parts, and becomes organized tissue within a week. The effectiveness and rapidity of growth of tissue are dependent upon efficient circulation in the parts from which the cells are derived and are retarded by excessive fluid exudate at the site of fracture. Therefore, every effort must be made from the beginning to help the efficiency of the circulation.

The circulation can be increased by the use of heat. The method of choice is the use of high frequency energy, preferably applied by the induction method. Blair[1] stated that heat can cause bony atrophy and that massage is not indicated before complete bony union has taken place. Kellogg Speed,[2] on the other hand, has shown that heat contributes to the production of a firmer union. In comparison with his control experiment, he stated that "heat produced less bulky callous, less fibrous and cartilaginous callous but more mature bony callous." Freeman, Merriman and Osborne[3] studied the effect of diathermy on the excretion of urinary calcium and inorganic phosphorous in 5 healthy male adults. The subjects were placed on a constant diet for seven days. Then for the following seven days a thigh of each subject was heated by inductothermy for one hour daily at the subject's maximum tolerance. In spite of this maximal test, there was no significant alteration in urinary calcium or inorganic phosphorous. Schmitt[4] has presented clinical evidence that heat produced by induction does not cause bony atrophy. His patients were given intensive inductothermy treatment. One patient with delayed union of nine months' standing was given 82 two hour treatments in sixty-nine days. Thus it seems unlikely that bony atrophy is caused by heat produced in this manner. Unfortunately, heat has been applied too often without consideration of the pathologic condition to be treated. Heat can be applied in such a way as to produce an active hyperemia or to such a point that passive congestion results. Not only is dosage important, but frequency of application must be given consideration in a prescription. For prolonged and frequent applications of short wave diathermy the induction field is the method of choice because of its physical adaptability to secure the desired distribution of power input, its applicability to all anatomic parts and its established heating characteristics.[5]

Functional disabilities are frequently caused from fibrosis in the soft parts due to organization of the exudates produced at the time of fracture and intensified by prolonged or intensive immobilization of joints and muscles. These disabilities can be minimized by employing within the first ten days physical measures which will provide for the removal of exudates and permit as much active exercise as is possible without interfering with the immobilization of the bone fragments. Heat, massage and exercise are important procedures in the care of fractures. Their therapeutic value, however, is dependent on the skill with which they are prescribed and administered. Superficial heating of the tissues can be secured by using a generator of thermogenic radiation (luminous or nonluminous) or by means of a whirlpool bath. Likewise, contrast baths may be used effectively for the

1. Blair, H. C.: The Alteration of Blood Supply as a Cause for Normal Calcification of Bone, Surg., Gynec. & Obst. 67:413, 1938.
2. Speed, K., and Egbert, H. F.: Temperature-Controlled Healing of Experimental Fractures, J. Bone & Joint Surg. 21:1005, 1939.
3. Freeman, S.; Merriman, J. R., and Osborne, S. L.: Unpublished data.
4. Schmitt, M. G.: Optimal Dosage in Short Wave Diathermy, Arch. Phys. Therapy 21:716, 1940.
5. Osborne, S. L., and Holmquest, H. J.: Technic of Electrotherapy—Its Physical and Physiological Basis, Springfield, Ill., Charles C. Thomas, Publisher, 1944.

treatment of poor vasomotor tone. The treatment for adaptive muscle shortening, which so often follows long periods of joint immobilization, should be further augmented by application of a brace so constructed that it concentrates its force directly at the joint affected (fig. 1). It should be worn in the interval between physical therapy treatments.

Every surgeon should know the elementary principles of massage.[6] As long as there is danger of displacement of fragments he should personally administer massage and early motion. The dominant effects of massage are on the nervous and peripheral vascular systems.

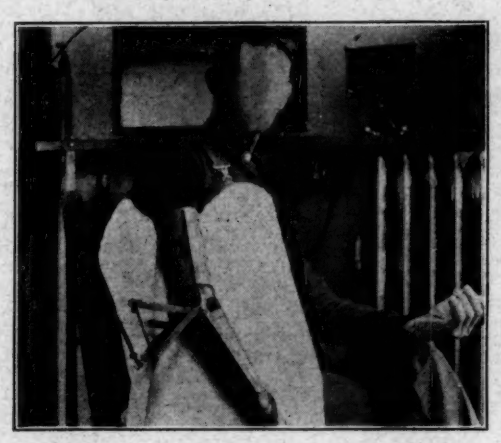

Fig. 1. — Brace used to maintain and increase the range of motion secured by massage and exercise at the elbow joint for a patient with adaptive muscle shortening.

The importance of a specific program of physiologic activity is becoming realized more and more by those responsible for the management of surgical patients. The institution of specific programs of active exercise both before and after operation has been found useful in preventing postoperative complications and in hastening postoperative recovery. With some one part immobilized, adjacent parts should be exercised. Too often the physician has been concerned with recovery of the diseased or injured region to the neglect of the general mental and physical make up. Therapeutic exercise is used to improve tonus of skeletal muscles and to counteract muscle weakness and muscle atrophy. Watson-Jones[7] has emphasized this point.

The treatment of strains, sprains and dislocations must be directed first to the immediate trauma which involves blood vessels, lymphatics and lacerated tissues. The next object of treatment is to assist in the removal and resolution of the vascular and lymphatic exudate which forms as the result of trauma. Heat by induction given for long periods but of low intensity is a valuable aid in gaining this objective. In addition to the judicious employment of heat, an appropriate type of electric current can be applied to stimulate the muscles controlling the joint, thus further aiding in the process. Bristow[8] advocated this during World War I, and Smart[9] more recently has emphasized its value. By this means it is possible to give a physiologic type of massage, not possible to produce by hand, which closely simulates nature's own method of massage. Early treatment is essential. Even

6. Storms, H. D.: Diagnostic and Therapeutic Massage, Arch. Phys. Therapy 25:550, 1944.
7. Watson-Jones, R.: Fractures and Other Bone and Joint Injuries, Baltimore, Williams & Wilkins Company, 1941.
8. Bristow, W. R.: Treatment of Joint and Muscle Injuries, London, Hodder & Stoughton, 1917.
9. Smart, M.: The Principles of Treatment of Muscles and Joints by Graduated Muscular Contractions, London, Oxford University Press, 1933.

though the electrical stimulation of a muscle is a valuable procedure, producing contractions to an exact degree, at a given rate and with a definitely controlled period of relaxation between contractions, it is no substitute for voluntary movements. The stage at which the patient should participate by voluntary action is well recognized, is encouraged when the right moment arrives and is then carried on pari passu with the treatment. Depending upon the severity of the lesion that a joint sustains, any or all of its various structures may be damaged to a greater or less degree; but in every instance the muscles activating the joint always suffer. Hilton[10] has shown that in joint injuries there is not only atrophy from disuse but atrophy from a nutritional reflex. According to King and Holmes,[11] this atrophy can take place within forty-eight hours when the joint injury is severe. Since joint function is dependent on muscular tone, electrical stimulation of the muscle should be employed early, to combat both forms of atrophy. However, it must not be forgotten that certain conditions are notoriously sensitive to excessive active use; that in which the danger is most commonly recognized is dislocation of the elbow, though certain derangements of the knee are also susceptible. Skilled medical supervision is essential.

Physical medicine has a definite place in the treatment of peripheral nerve lesions. The value of muscle reeducation is fully appreciated. An outstanding book dealing with this work is "The Action of Muscles," by McKenzie.[12] Massage, too, has been assigned a definite role, although from the work of Waddell, Feinstein and Pattle[13] it appears that its technic of application have to be changed. The use of heat in the treatment of nerve lesions has not had such universal acceptance because of the sensory changes so likely to be present. However, recently Bauwens[14] stated:

> Provided the circulation in a paralyzed limb is capable of being accelerated, a rise in temperature and efforts to keep this near to the normal constantly are indicated, in order to promote repair, facilitate movement and increase excitability. This is best achieved by warming the limb in the high frequency field provided by coil electrodes. It is not enough to warm merely the affected cold part of a limb, as much as possible of the portion above the level should be treated so as to enhance the circulation generally.

He further stated that treatment should be given twice daily and every effort made to prevent heat loss between treatments.

There is a sharp boundary between the nervous and muscular tissue, and, if the nerve is divided, the acute degeneration of the nerve fiber stops at the ending in the muscle. The end plate does not disappear. Nevertheless, such a denervated muscle undergoes a rapid and dramatic atrophy. The contraction which the muscle gives when electrically stimulated is much prolonged after denervation, but little evidence of the significance of this fact is available.

The theories of the causes and nature of muscular atrophy are numerous, but none is conclusive. The denervated tissue is hyperexcitable and its fibers go into that continuous ineffective flickering contraction which is known as fibrillation. Many have suggested that it is this activity which causes the wasting, that atrophy is a result of overactivity rather than underactivity — overactivity in the absence of the usual vascular responses of the muscle. But there is much to show that fibrillation is not the cause of atrophy. Quinidine, which prevents fibrillation, does not arrest the wasting.

10. Hilton, J.: Lectures on Rest and Pain, London, George Bell & Sons.
11. King, J. M., and Holmes, G. W.: Diagnosis and Treatment of 450 Painful Shoulders, J. A. M. A. 89:1956, 1927.
12. McKenzie, W. Colin: The Action of Muscles, New York, Paul B. Hoeber, Inc., 1921.
13. Waddell, G.; Feinstein, B., and Pattle, R. E.: The Electrical Activity of Voluntary Muscle in Man, Brain 67:178, 1944.
14. Bauwens, P.: Heat and Electricity in the Treatment of Nerve Lesions, Brit. J. Phys. Med. 5: 48, 1942.

The value of stimulating the denervated muscle by electrical currents was first demonstrated and reported by Reid[15] in 1841. A critical evaluation of the experimental work which had accumulated since 1844 was made in 1942 by Osborne and Grodins.[16] They showed that certain general observations could be made. In general, when daily treatment was given, when the periods of stimulation were relatively long and when the current strength was sufficient to cause a vigorous muscle contraction, the results were favorable. Without exception, those who employed weak stimuli or short single periods of stimulation reported unfavorable results. The type of stimulating current used is important. Osborne, Grodins, Mittleman, Milne and Ivy[17] made an investigation to ascertain the type of electrical current required for stimulation of the normal and denervated muscle. They reported that a modulated alternating current with a variable carrier frequency proved to be satisfactory. From their data a muscle stimulating generator has been designed and is now in the process of manufacture. This generator will permit not only variation of modulation but also variation of the carrier frequency, so that one can select the optimal frequency to produce the maximal muscle tension with the least current intensity. This form of current has not been employed before, although both Briscoe[18] and Fischer[19] have used similar methods. By use of the optimal frequency the denervated muscle can be made to contract with a smoothly fused tetanic contraction. Within the last four years evidence has been presented by Fischer,[19] Solandt,[20] Hines,[21] Grodins, Osborne and Ivy,[22] Gutmann and Guttmann [23] and Kosman. Osborne and Ivy[24] showing that electrical stimulation of the denervated muscle can markedly diminish the rate of atrophy and loss of strength. The factors responsible for these effects are unknown, but the treatment does restore to the muscle something of its normal action. It is suggestive that when the muscle fibers are made to contract, as they normally are by stimuli from outside themselves, they waste little.

The denervated muscle wastes least if allowed to shorten during electrical stimulation. The greatest effect is found when the muscles are subjected to the maximal stretch and restrained by weights so as to prevent shortening. It seems probable that the optimal conditions for the maintenance of muscle fibers is that they contract against resistance and, if allowed to shorten, are then again stretched. In fact, it seems that the atrophy of the denervated muscle is connected with the fact that it is not made to do proper work. To be effective in retarding muscle atrophy and loss of strength, the following factors must be observed: (*a*) A modulated alternating current with the proper carrier frequency must be used to secure maximal tension of the fibers stimulated; (*b*) vigorous exercise is essential, i. e., work must be done by the muscle; (*c*) long periods — broken up into several sessions — of stimulation are necessary; (*d*) treatment must be started early.

In the treatment of amputations, physical medicine procedures can be

15. Reid, J.: Edinburgh Monthly J. M. Sc. 1841.
16. Osborne, S. L., and Grodins, F. S.: The Electrical Stimulation of Denervated Muscle, Physiotherapy Rev. 22:291, 1942.
17. Osborne, S. L.: Grodins, F. S.; Mittelman, E.; Milne, W. S., and Ivy, A. C.: Rationale for Electrodiagnosis and Electrical Stimulation in Denervated Muscle, Arch. Phys. Therapy 25:338, 1944.
18. Briscoe, Grace: Experimental Production of Graded Muscular Contraction of Natural Form in Diaphragm and in Skeletal Muscle, Quart. J. Exper. Physiol. 19:1, 1928.
19. Fischer, E.: Effect of Faradic and Galvanic Stimulation Upon Course of Atrophy in Denervated Skeletal Muscles, Am. J. Physiol. 127:605, 1939.
20. Solandt, D. Y.; De Lury, D. B., and Hunter, J.: Effect of Electrical Stimulation on Atrophy of Denervated Skeletal Muscle, Arch. Neurol. & Psychiat. 49:802, 1943.
21. Hines, H. M.; Thomson, J. D., and Lazere, B: Physiological Basis for Treatment of Paralyzed Muscle, Arch. Phys. Therapy 24:69, 1943.
22. Grodins, F. S.; Osborne, S. L.; Johnson, F. R.; Arana, S., and Ivy, A. C.: The Effect of Appropriate Electrical Stimulation on Atrophy of Denervated Muscle in the Rat, Am. J. Physiol. 142:222, 1944.
23. Gutmann, E., and Guttmann, L.: The Effect of Galvanic Exercise on Denervated and Re-innervated Muscles in the Rabbit, J. Neurol., Neurosurg. & Psychiat. 7:7, 1944.
24. Kosman, A. J.; Osborne, S. L., and Ivy, A. C.: The Effect of Electrical Stimulation Upon the Course of Atrophy and Recovery of the Gastrocnemius of the Rat, Am. J. Physiol. 145:447, 1946.

most helpful. The circulation of the stump can be stimulated, edema decreased, adherent scar tissue loosened and muscle tone and strength improved. In amputation of the lower leg, contractures can be prevented. The stump can be shrunk and toughened by use of a simple apparatus consisting of a short length of wooden curtain pole, attached by two metal supports encased in a plaster bucket. In this manner much time can be saved and less difficulty is encountered in learning the use of an artificial limb (fig. 2). Naturally, reeducation exercises play an important role in the rehabilitation of these patients.

The treatment of backache is not simple, and physical therapy is but one of the many measures used to bring relief for the patient. However, careful attention should be given to manipulative therapy as outlined by Jostes.[25]

Fig. 2. — A simple inexpensive walking device to prepare an amputation stump for an artificial leg and to assist in overcoming muscle contracture.

He has approached the problem from an anatomic viewpoint. In a recent article[26] he stated: "In recent years the surgical approach in the treatment of painful backs and sciatic irritation has done much to mask the rationale of conservative treatment. It has been proved that operation is not always indicated for disc involvement, and in many instances is futile." According to Jostes, active treatment of low back pain consists of bed rest; heat, massage, manipulation, support, exercise and operation. It is not enough to secure relief of pain. Such a course only invites chronicity. Supportive measures such as exercise, postural correction with support, postural rest, heat, massage and bed correction are among the procedures considered to secure continued relief.

Attention should be called to an excellent book, entitled "Pain Mechanisms — A Physiologic Interpretation of Causalgia and Its Related States," by Livingstone.[27] The book contains a rather challenging chapter on low back pain disability. Livingstone believes that procaine injected into certain sensitive "trigger points" is worthy of a trial both as a means for determining

25. Jostes, F. A.: Manipulative Therapy for Back Conditions, Principles and Practice of Physical Therapy, Hagerstown, Md., W. F. Prior Company, Inc., 1934, vol. 3, chap. 3.
26. Jostes, F.: Place of Manipulative Procedures in the Overall Treatment Rationale for Painful Back Conditions, Arch. Phys. Therap. 25:716, 1944.
27. Livingstone, W. K.: Pain Mechanisms: A Physiologic Interpretation of Causalgia and Its Related States, New York, The Macmillan Company, 1943.

the course of pathologic reflexes and as a method of treatment. He believes it to be not a panacea but merely a useful adjunct to other treatment. This is of special interest in view of some recent work by Waddell, Feinstein and Pattle.[13] These authors wrote:

> Elliott has drawn attention to the fact that tender spots or nodules supplied by "irritated nerve roots" are the seat of increased motor unit activity — there is a close parallel as regards spontaneous repetitive motor unit activity, between the findings of fasciculation induced by prostigmine and certain cases of sciatica. Pain in the nodules is abolished by the local infiltration of procaine. And the suggestion has been put forward that the spasm itself is the source of the pain. Our findings, however, suggest that the pain in sciatica may be the result of changes in sensory nerves which parallel those occurring in motor nerves.

Copeman and Ackerman[28] have shown that these "trigger points" are associated with certain areas of the back where pink fatty tissue of a particular type lies between the superficial and the deep fascia. The fat is vascular and liable to become edematous and congested, possibly under the influence of meteorologic and other factors, and may thus narrow the lumen of the tendon sheaths and cause stiffness and pain. A similar effect may arise in other situations, and this may furnish at least one plausible explanation of the characteristic symptoms of acute lumbago. This underlying fat, when congested and swollen, tends to bulge through any weak spots or deficiencies in the enveloping fibrous layers or through the foramens which give passage to the nerves and blood vessels; these herniations form tender nodules and trigger points.

The important role that occupational therapy plays in the proper economic adjustment of the injured workman should be stressed. The first step in rehabilitation is to obtain the cooperation of the patient and awaken his will to recover. This type of occupational therapy should be prescribed by a physician, for the successful application of this therapy demands a thorough knowledge of physiology, pathology and bodily mechanics. In planning the treatment of an injured workman the physician should keep in mind Griffiths'[29] theory of conditioned reflexes. He stated, in part:

> The conditioned reflex adds the power producing factor of repetition, and this in the deliberately acquired reflex was originally the result of conscious effort. Impulsive action, although not a true acquired conditioned reflex, is produced by the cortical memory of deliberate action freed by practice from the psychological inhibitions associated with conscious deliberation. Deliberate action becomes an effort of will power or thought; but for deliberate muscle action to be developed into a state of skilled muscle action a period of training is necessary, requiring concentrated mental effort and practice, and this can lead to the desired skilled action as experience is obtained. Finally, something more is needed before the skill becomes expert. This extra something is not only experience but represents a definite advance in pure psychical effort.
>
> The inhibition of the conditioned reflex may be either external or internal. The external inhibition is produced by some excitatory processes other than the conditioned stimuli in the central nervous system, and of these pain, the anticipation of pain or other fear are of greatest importance.
>
> The conditioned reflex of industry is a very complex affair. Take, for example, the skilled carpenter using a saw. The action is one of pushing and pulling the saw, but long practice has produced a conditioned reflex in which each stroke of the saw corresponds almost exactly with the previous or succeeding strokes. The reflex developed is a nice example of negative successive induction, but it is not the simple affair of alternate contraction and relaxation of the triceps or of the serratus magnus and latissimus dorsi muscles. The beautifully balanced muscle action involved depends on many different conditioned stimuli.
>
> To mention only a few of these: There are the touch stimuli from both hands. In the saw hand a definite tactile discrimination is associated with the man's own saw (as every tradesman uses his own tools). Thus the same part of the skin of his hand

28. Copeman, W. S. C., and Ackerman, W. L.: Fibrositis of the Back, Quart. J. Med. 13:37, 1944.
29. Griffiths, H. E.: Treatment of the Injured Workman, Lancet 1:729, 1943.

is stimulated every time he grips this particular saw. There is the stimulus of bone vibration set up by the wavelength of the saw being used, so that the farther the saw is thrust the shorter the vibration wave, ultimately suggesting the point at which the reflex action of the thrust shall be reversed. There is, in addition the sound reflex, the rasp of the saw, and here again the note alters with the progress of the saw through the wood. When the conditioned reflex is first established a knot in the wood will cause a temporary interruption in the reflex path and tend to throw the muscles out of proper coordination so that there must be a period of conscious action before reflex action is reestablished. But as time goes on the extra resistance of a knot in the wood itself produces a superimposed conditioning stimulus and sets forth a bigger muscular effort without interfering with coordination.

In considering all these industrial conditioned reflexes, one, the law of summation of conditioned reflexes must be borne in mind. This states that when different conditioned stimuli will each call forth a similar reflex, the stimuli acting together will produce a greater effect than they do when acting alone. A conditioned reflex may be reduced but not lost by interference with one of the conditioned stimuli, provided the other conditioned stimuli are sufficiently strong to overcome the inhibiting effect of the lost stimuli.

With the injured workman, bed treatment is only a minor problem. Over 99 per cent of the injured can and should receive ambulatory treatment, and this must be designed to ensure that they use their conditioned reflexes and so secure the maximum amount of exercise with the minimum amount of fatigue. Man's ordinary walking gait is a combination of postural reflexes with the stepping reflex and various conditioned reflexes, not the least of which is produced by the sensation of the impact of the ground transmitted through the sole of a shoe or boot. Treatment therefore must be aimed at restoring normal walking conditions at the earliest possible moment.

Finally we come to the question of vocational exercise associated with the patient's work. This aspect of treatment must be attempted only when its practice will not produce any of those factors which inhibit the conditioned reflexes which are the foundation of his skill.

As an example, take the carpenter, who has an injured wrist and is asked to use a screwdriver. The normal action of driving a screw is for him a conditioned reflex, but pain inhibits this reflex action and it does so in this way: In the first turn made, perhaps the normal conditioned reflex was obtained, but with it pain; the movement now becomes conscious movement and the anticipation of the pain produces a static contraction of muscle to resist the anticipated movement. This inhibits the conditioned reflex with resultant incoordination of muscle action and loss of power. But the effect does not end there. With pain and work linked in the man's mind, fear is born — the fear of incapacity for work — and this fear still further inhibits the conditioned reflex. It has been a mistake, therefore, to attempt to restore the conditioned reflex of the man until the arm has become relatively free from those factors of pain and stiffness which would inevitably inhibit the desired action.

What has been said of vocational therapy applies equally to so-called "light work." The man has been given work of a lighter character in his own trade before he is sufficiently free from pain and while still liable to early fatigue. As a result, he develops inhibition of his previously work-conditioned reflexes, leading to increased clumsiness and to despondency. If he has not been employed at the lighter forms of his old job, all too often he has been given work which involves industrial degrading — bricklayer becomes a tea-boy — and one of his worst fears is realized. His mind now becomes so concentrated on the injured part that subconscious movement becomes almost impossible and the most rapid road to recovery — restoration through exercise — is barred to him.

AN ULTRAVIOLET INTEGRATOR FOR MEASURING PRESCRIBED DOSAGE *

CLIFTON BERNARD COSBY, M.A.

RICHMOND, VA.

Ordinarily the correct dosage of ultraviolet energy is provided in three steps. First, the lamp is standardized so that one knows the time for irradiation to give an average patient with an untanned skin a minimally perceptible redness at a fixed treatment distance. This testing of the lamp may be done directly on several test subjects who seem to approach the average of patients, or on the particular patient to be treated; or the intensity of the lamp may be judged by any of several photochemical reactions in the ultraviolet whose yield of reactants, judged by color or otherwise is taken as proportional for a given time to the intensity of the source; or, the lamp may be standardized by means of any of several available physical instruments, such as photoelectric light meters or a standardized thermopile and galvanometer. The standardization of the lamp may be in ergs per square centimeter per second, in watts per square centimeter or in minutes required at the treatment distance (usually 30 inches) to produce minimally perceptible redness on an average previously unexposed patient. If the standardization is done directly on the patient to be treated, his particular minimal dose is known in minutes.

Second, whether the judgment of the intensity of the source is had by direct, chemical or physical means, the next problem is to determine whether a given patient with a diagnosed condition needs much or little ultraviolet energy, in terms of ergs or watt-seconds. In the language of drug therapy, shall the patient be given a dose of 1 grain of the agent of therapy or several? This measurement of light energy as in bucketfuls of a certain range of frequencies is a novel concept to many, but for the therapist it is essential.

The difficulty in determining the prescription in energy units is beyond the scope of this paper to solve. In general, the closer one approaches the accurate rendition of the dose, the more nearly the physician can judge his results and attribute them quantitatively to the agent.

Third, once the dosage has been prescribed, the time of treatment or the distance of the lamp from the patient and the time of treatment can be regulated to give the desired dosage.

It appears that the first and third step, the standardization of the source and its regulation to give the dosage, may be telescoped together automatically by an electronic device to render the dosage once the prescription is in hand. If the photoelectric dosimeter takes a continuous but constant sample of the energy delivered toward the patient during treatment, totalizes it to some preset level, as judged from the physician's prescription, and stops the treatment when the required energy has been received by the patient, this purpose will be accomplished.

The instant device is in a portable case with a standard cord and plug for insertion in the wall outlet, with a covering lid to protect the instrument panel and a receptacle to receive the plug of the clinical lamp used (fig. 1). It also has a bracket support for the photoelectric cell designed to fix the

* From the Baruch Center of Physical Medicine, Medical College of Virginia.
* Read at the Twenty-Fourth Annual Session, American Congress of Physical Medicine, New York, Sept. 6, 1946.

sensitive cell and such filters as are desired at the treatment distance but to one side of the line of irradiation to the patient. It is essential that the photo cell always be arranged at the same relative portion of the field, should it be moved from one clinical lamp reflector to another, if one wishes to preserve the energy unit calibration.

The controls consists of two dial potentiometers and two switches. The control on the right of the figure is used for presetting the dose in either erythemal or physical energy units. The differently colored dial lamps light to indicate that the circuit is connected to the line and that a cycle of integration is in operation.

It has been suggested that a circuit based on a similar principle to that

Fig. 1. — The integrator shown attached to a clinical lamp, the photo tube should be fixed at a treatment level to one side of the line of irradiation and the lamp line cord plugged into the receptacle of the integrator.

for spectrographic exposure control be adapted to the problem of timing clinical ultraviolet treatment.[1]

The precise photoelectric measurement of the intensity of ultraviolet energy has had the attention of international commissions.[2] Generally, photoelectric devices are of two types: those that read by photo cell and a sensitive meter the intensity of ultraviolet radiation,[3] and those which charge a condenser and fire a gas tube when spilling over, finally clicking a relay, the frequency of the clicks being a measure of the intensity. When using a pen graph, the last device is a means of integration of the energy with time.[4] A development of the latter type is the use of a ratchet and toothed wheel to integrate the mechanical impulses from a relay.[5]

The instant device integrates directly and when a preset limit of total energy is reached breaks the supply circuit of the light energy source. For comparison of sources (assuming supply voltage to be constant), the times of irradiation to cause the relay to operate are a measure of the intensity.

1. Cosby, J. R.: Graduate Thesis, Blacksburg, Va., Virginia Polytechnic Institute, 1940, Spectograph Exposure Control, Electronics 19:123 (April) 1946.
2. Coblentz, W. W.: The Measurement of Ultraviolet Radiation Useful in Heliotherapy, J. Optic. Soc. America 36:72 (Feb.) 1946.
3. Coblentz, W. W., and Stair, R.: A Portable Ultraviolet Intensity Meter, Consisting of a Balanced Amplified, Photoelectric Cell and Microammeter, Bureau of Standards J. Research 12:231, 1934.
4. Report of the Council on Physical Therapy, J. A. M. A. 104:315 (Jan. 26) 1935.
5. Taylor, A. H.: Portable Ultraviolet Meters, J. Optic. Soc. America 24:183 (July) 1934. Luckiesh, M.; Taylor, A. H., and Kerr, G. P.: Ultraviolet Energy in Daylight: A Two Year Record, J. Franklin Inst. 223:699 (June) 1937.

A voltage is built up on a condenser *C* from photo tube *P*, to a voltage preset by the variable control on indicated diode of tube 2. For continuous operation a small AC ripple is supplied at *X*. The grid of the 6SJ7 tube is thus actuated by pulses when the integrated value is reached. The pulses are amplified by the 6SJ7 tube and rectified by tube 3. Spurious short duration impulses are rejected by the R-C timing circuit in the grid of the 2050 gas tube, the negative bias being supplied by the 6H6 rectifier tube numbered *1*. Upon overcoming the negative bias on the grid of the gas tube, the impulse, having been passed by the timing circuit because of long duration, fires the tube, resulting in operation of the relay to interrupt the energy supply of the clinical lamp. To reset, switches S_1 and S_2 are operated simultaneously, S_1 shorting condenser *C* and S_2 opening the plate circuit of the gas tube. Then the switches are set in the opposite position for operating. In practice, the clinical lamps are warmed up with the shutters closed. When treatment is begun, the shutters are opened, the treatment switch set for

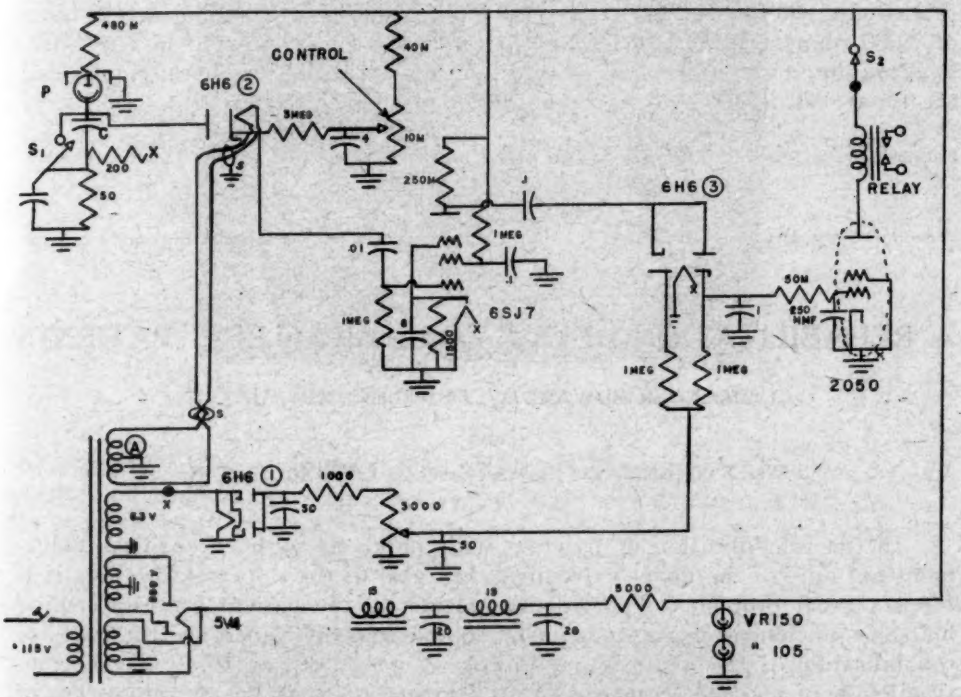

Fig. 2. — The circuit for electronic integration of ultraviolet energy which automatically cuts off the clinical lamp when the dose is completed.

operating continuously from the beginning of the warm-up period. The shutters must be practically light tight.

An RCA 935 photo tube has been used. In lamps the reflector housings of which do not exceed the recommended ambient temperature limits of the photo tube, the photosensitive tube could be clamped to the reflector and to one side of the line of irradiation and standardized in this position. Ordinarily the best position is at the treatment level. This placement has the advantages of avoiding deterioration of the cell because of too intense flux and high ambient temperature and of providing more accurate measurement of the energy at the point to be used.

A quartz water cell and Corning filters over a slit have been used to select the broad band measured. This seems acceptable for separating out

the therapeutic wavelengths for usual clinical measurement.[6]

A conventional 5V4 power supply with voltage regulator tubes is indicated. Winding *A*, perhaps, should be of shielded and of low loss construction for precise work. As an alternative method for variation in timing for standardizing the circuit to a particular clinical lamp, the photo tube could be adjusted by setting the operating anode to cathode voltage of the photo tube from the variable arm of a potentiometer connected from high voltage to the ground. A decade condenser for *C* has also been used, as well as some adjustment of the variable negative bias on the 2050 tube. Once a source of ultraviolet rays and integrator have been adjusted for correct reading of the dial calibration in energy units, the combined devices will give uniform dosages as set by the variable control independent of usual line voltage variation and decline in energy output of the lamp with use. For the small slit and lower ambient temperatures encountered in the recommended arrangement of the photo cell, the photo cell errors are expected to be comparably small. The relay is rated to open a 15 ampere, 115 volt AC circuit when actuated by 30 milliamperes in its coil having a resistance of 3,000 ohms. While the circuit was devised for dosimetry in the ultraviolet range, it should prove useful in longer wave radiation therapy, provided the photo cell is replaced with another of proper characteristics.

6. Coblentz, W. W.; Stair, R., and Hogue, J. M.: Tests of a Balanced Thermocouple and Filter Radiometer as a Standard Ultraviolet Dosage Intensity Meter, Bureau of Standards J. Research 8:759, 1932.

A REHABILITATION DEVICE FOR PARAPLEGIC PATIENTS

COMMANDER EDWARD W. LOWMAN (MC), U. S. N.

and

CHIEF PHARMACISTS MATE FRED LIPHUM, U. S. N.

In the rehabilitation of patients with paralysis with extensive involvement not only of the lower extremities but also of the upper extremities it is often a great problem to provide the means to the patient for establishing his self sufficiency. Since independence and self sufficiency are the roots of rehabilitation, the problem is in the more urgent need of solution. The introduction of any aids toward accomplishment of this end, therefore, are of significant import. The difference between ability and inability to accomplish simple everyday tasks, such as combing one's hair, brushing one's teeth and feeding one's self, is the narrow margin that separates independence from dependence.

In the rehabilitation of patients with spinal cord injuries, often it is the case in those with high lesions that in addition to complete paralysis of the lower extremities there is serious impairment of function in the muscles of the upper extremities. It is fortunate, however, in patients who survive, with these high cord lesions that the shoulder, upper arm, forearm, wrist, and fingers are paralyzed in inverse order and that rarely in a quadriplegic patient is there loss to such an extent that he cannot use his shoulder and at least partially use his arm; it is common, on the other hand, for there to

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be loss of function in fingers, wrists and, to a less degree, in forearms and elbows.

The prognosis for restoring functional hands and forearms often proves extremely poor, and the patient is left with complete or partial function of the shoulder and arm but with marked weakness or paralysis of the wrist and hand to an extent sufficient to nullify the functional value of the extremity.

For such patients, there has been helpfully utilized in one Naval Hospital a simple device which greatly augments the personal independence of the patient. The device (fig. 1) is a light metal band which fits around the

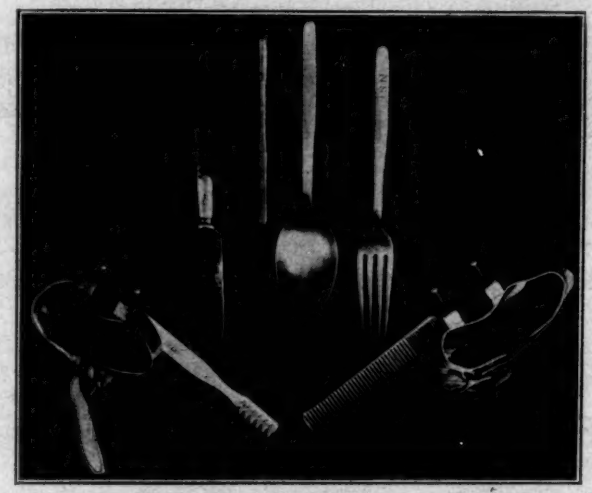

Fig. 1. — Many appliances may be adapted to use in the device

metacarpal portion of the hand and is secured by a leather strap and buckle dorsally. On the palmar surface are two light metal blocks with slots and turn-screws. Into these slots may be secured a toothbrush, eating utensils, a comb, various occupational therapy tools, etc. (fig. 2). If there is weak-

Fig. 2. — Personal independence can be augmented considerably

ness of the wrist and/or forearm, appropriate additional extensions may be added to hold the wrist and forearm in the position of greatest functional value.

AMERICAN CONGRESS OF PHYSICAL MEDICINE — WESTERN SECTION

The summer meeting of the Western Section will NOT be held at San Francisco in July as was previously announced. We hope no member is embarrassed by this cancellation.

The Western Section meeting will be held in Minneapolis during the Twenty-Fifth Annual Scientific and Clinical Session of the American Congress of Physical Medicine; the announcement will appear there.

Theodore Stonehill, M.D.,
Chairman.

POLIOMYELITIS CONFERENCE SET FOR WARM SPRINGS, GEORGIA, SEPTEMBER 15, 16 AND 17

Marking the twentieth anniversary of the founding of Georgia Warm Springs, a three-day clinical conference on diagnosis and treatment of poliomyelitis will be held at Warm Springs, Georgia, on September 15, 16 and 17.

The clinical conference will be led by approximately twenty of the nation's authorities in the fields of neurology, pathology, pediatrics, orthopedics, physical medicine and internal medicine who will present papers reviewing the advances in poliomyelitis knowledge in these fields.

The papers and discussions will constitute a new book on diagnosis and treatment of the disease for publication in 1948. Clinical demonstrations of modern treatment methods will be given by the medical staff of the Warm Springs Foundation.

Physicians interested in attending this conference should make inquiries to the Georgia Warm Springs Foundation, 120 Broadway, New York 5, N. Y. Complete program of the meeting will be available on request.

ARCHIVES of PHYSICAL MEDICINE
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EDITORIALS

HOT PACKS AND MUSCLE STRENGTH

The phenomenon of decreased muscular contraction with the application of hot packs in the anesthetized animal as described by Hall *et al.* in this issue of the ARCHIVES is an important observation of interest to both clinician and physiologist. The abolition of this decrease in muscular contraction by cutaneous anesthesia brings up for discussion the possible mechanisms that play a role in this phenomenon. The decrease in muscular contraction occurred only in those experiments when the peripheral end of the cut seventh ventral lumbar root was electrically stimulated, leaving the afferent and autonomic innervation intact. Stimulation of the distal end of the cut sciatic nerve (excluding any autonomic and sensory reflex action) failed to show a decrease in muscular contraction during application of hot packs. Thus the controversial subject of direct and indirect action of the autonomic nervous system on skeletal muscle might be explored for a clue to possible mechanisms to explain this "reflex" decrease in strength of muscular contraction associated with hot applications.

On the basis of subcutaneous and deep muscle temperatures, blood pressure changes, and work of previous investigators, the authors postulate that a reflex vasoconstriction in the skeletal muscle, initiated by pain receptors in the region of the hot pack, accounts for the diminished muscular contraction. Previous workers[1] have shown that with gross reduction of arterial circulation, by clamping the abdominal aorta in anesthetized animals, rapid fatigue of the electrically stimulated muscles of the lower extremity occurs. Under the conditions of the experiments reported by Hall and associates, however, one may question the evidence in support of a reflex vasoconstriction to account for the diminished muscular contraction.

Several points of interest can be discussed briefly regarding the relationship between rise in deep muscle temperature and blood flow. The authors state . . . "Since the blood enters the muscle with a temperature close to that of the body (which averaged 37.7 C.) and since the deep muscle temperature averaged close to 35 C. during contraction just before application of the pack, the rise in muscle temperature (other factors remaining sufficiently constant as was the case) is proportional to the blood flow rate through the muscle." The validity of such an assumption under the conditions described is problematical. It is known, for example, that when the local surface temperature is elevated above the normal skin temperature, the arterial circulation conducts heat away from the part exposed, and acts as a cooling mechanism. Abramson[2] states that with local heating in the presence of arterial insufficiency there is a greater rise in deep temperature because of slower rate of heat dissipation than occurs with normal blood flow. In view of this, the evidence presented by the authors in those experiments showing a smaller rise in muscle temperature per degree rise in subcutaneous temperature might indicate more efficient arterial circulation rather than the opposite con-

1. Baetjer, A. M.: The Relation of the Sympathetic Nervous System to the Contractions and Fatigue of Skeletal Muscle in Mammals, Am. J. Physiol. 93:41 (May) 1930.
2. Abramson, D. I.: Vascular Responses in the Extremities of Man in Health and Disease, Chicago: University of Chicago Press, 1944, pp. 92-93.

clusions. It is probably more accurate, however, to state that other factors such as the heat of muscle contraction (which did not remain constant in those experiments where the reflex occurred), variability of the surrounding temperature and of the hot packs, make these temperature measurements precarious evidence from which to conclude changes in blood flow rate.

It is well established by experiments in the human that elevated temperatures[3] as well as the accumulation of local metabolites[4] in the contracting muscle are powerful vasodilators. It has been shown that the vasodilatation to heat does not depend on the integrity of the autonomic nervous system.[5] In view of this, more evidence is to be desired before postulating reflex vascular constriction under these conditions. The experiments of Kuntz and Haselwood[6] dealing with reflex vascular changes in the gastrointestinal tract are submitted as supporting evidence by the authors that such changes can occur. It is well to note, however, that Kuntz *et al.* reported only transient vasoconstriction in the large intestine following application to the skin of packs above 52 C., and vasodilatation in the range of temperature between 45 C. and 52 C. The temperatures reported by Hall *et al.* were 41 to 53 C. In any case, reflex changes in circulation in smooth muscle frequently differ from those found in skeletal muscle.

The possibility of a direct effect of the autonomic nervous system on contracting muscle, rather than indirectly through the circulation, has long occupied the attention of physiologists. The Orbeli effect, first described on isolated frog muscle, then confirmed on mammalian skeletal muscle,[7] demonstrates that stimulation of the sympathetic nerves to a contracting muscle will diminish fatigue and increase contraction strength in the absence of circulation. Bülbring and Burn[8] have shown in the dog that "stimulation of the sympathetic chain during muscle work diminishes the blood flow, but nevertheless increases the tension." In light of this direct action of the autonomic nervous system on skeletal muscle, it is conceivable that other reflexes than vasoconstriction may account for the diminished contraction strength observed with hot packs.

A further factor to be considered is the diffuse segmental innervation of the gastrocnemius muscle which includes lumbar roots five to seven and the first sacral.[9] The contraction of the muscle can initiate stretch reflexes which might stimulate contraction of gastrocnemius fibers other than those supplied by L_7 and thus influence the height of contraction. The anterior tibial is also partially innervated by L_7 and other roots left intact and, being an antagonist, might also alter the results through stretch and other reflexes.

Despite the theoretical considerations and objections raised in this discussion as to possible mechanisms, we do not wish to exclude the conclusions given by the authors. It is to be hoped that more direct evidence of circulatory changes will be forthcoming from future experimentation to support their thesis. Such studies might also include elimination of autonomic effects by drugs or sympathectomy and further investigation of the nervous pathways involved. They are to be commended for investigating a reflex that most certainly has wide significance, and although they correctly warn against clinical application of conclusions based on animal experiments, it is from work such as this that physical medicine can find a more rational basis for therapy.

3. Barcroft, H., and Edholm, E. G.: The Effect of Temperature on Blood Flow and Deep Temperature in the Human Forearm, J. Physiol. 102:5 (June) 1943.
4. Grant, R. T.: Observations on the Blood Circulation in Voluntary Muscle in Man, Cl. Science 3:157 (April) 1938.
5. Freeman, N. E.: The Effect of Temperature on the Rate of Blood Flow in the Normal and in the Sympathectomized Hand, Am. J. Physiol. 113:384 (Oct.) 1935.
6. Kuntz, A., and Haselwood, L. A.: Circulatory Reactions in the Gastrointestinal Tract Elicited by Localized Cutaneous Stimulation, Am. Heart J. 20:743 (Dec.) 1940.
7. Wastl, H.: The Effect on Muscle Contraction of Sympathetic Stimulation and of Various Modifications of Conditions, J. Physiol. 60:109 (July) 1925.
8. Bülbring, E., and Burn, J. H.: Blood Flow During Muscle Contraction and the Orbeli Phenomenon in the Dog, J. Physiol. 95:203 (Feb.) 1939.
9. Huddleston, O. L., and White, C. S.: Segmental Motor Innervation of the Tibialis Anterior and Gastrocnemius-Plantaris Muscles in the Dog, Am. J. Physiol. 138:772 (April) 1943.

AMERICAN BOARD OF PHYSICAL MEDICINE

General Information: Qualification of Candidates for Certification.

Each applicant for admission to the examination shall be required to present evidence that he has met the following standards:

A. General qualifications. 1. Satisfactory moral and ethical standing in the profession. 2. Membership in the American Medical Association or membership in such Canadian or other medical societies as are recognized for this purpose by the Council on Medical Education and Hospitals of the American Medical Association. (Exceptions to the foregoing qualifications shall be made by the American Board of Physical Medicine for good and sufficient reasons.)

B. Profession qualifications. 1. Graduation from a medical school recognized by the Council on Medical Education and Hospitals of the American Medical Association. 2. Completion of an internship, preferably of the general rotating type, of not less than one year in a hospital approved by the same council.

C. Special training. 1. A period of study after the internship of not less than three years in clinics, dispensaries, hospitals or laboratories recognized by the same council and by the American Board of Physical Medicine as competent to provide a satisfactory training in physical medicine. 2. This period of specialized preparation shall include: (a) Graduate training in anatomy (including kinesiology and functional anatomy), physics (including radiation physics, electronics and medical instrumentation), physiology, pathology, and other basic sciences which are necessary to the proper understanding of physical medicine; (b) An active experience of not less than 2 years in hospital clinics, dispensaries and diagnostic laboratories recognized by the Council and the American Board of Physical Medicine; (c) The written and oral examinations, given by the American Board of Physical Medicine, shall include questions concerning the basic sciences, clinical practice, and laboratory and public health problems as related to physical medicine. 3. An additional period of not less than two years of study and/or practice in physical medicine.

Outline of the Proposed Methods of Examination

The first examination will be held on August 31 and September 1 at the Hotel Radisson in Minneapolis. All inquiries should be addressed to Dr. Robert L. Bennett, Secretary-Treasurer, American Board of Physical Medicine, 30 North Michigan Avenue, Chicago 2.

Physical Medicine includes the diagnosis and treatment of disease by means of physical agents. These physical agents include heat, water, electricity, ultraviolet and infrared radiation and mechanical devices and agents (such as massage and therapeutic exercise). Physical Medicine has been termed medical applied biophysics. As now practiced, the special field of physical medicine includes (1) the employment of physical agents in diagnosis (as in electrical tests for reaction of degeneration or in the cold pressor test), (2) the employment of physical agents in treatment, (3) occupational therapy and (4) the physical rehabilitation of convalescent and disabled patients. The physician who specializes in physical medicine must have a thorough knowledge of the basic sciences as related to these subjects as well as clinical practice in the various phases of physical medicine.

Written and oral examinations will be given which will assure the board that the applicant is thoroughly grounded in:

A. The basic sciences including: a. anatomy (including kinesiology

and functional anatomy). Because of the importance of proper knowledge of the function of muscles in conjunction with the administration of therapeutic exercise and physical reconditioning of convalescent and disabled patients, the applicant will be carefully examined concerning his knowledge in this field. b. physics (including radiation physics, electronics and instrumentation). Because physical medicine deals largely with the employment of physical agents, in diagnosis and treatment, the applicant will be expected to be well informed concerning the fundamentals of medical physics. He will be expected to be familiar with such subjects as the physics of heat, ultraviolet and infrared radiation, and electricity (including the physics of low voltage currents and high frequency currents as employed in medicine). Because of the newer developments in medical electronics and medical instrumentation, the applicant will be examined concerning these subjects. c. physiology. The applicant will need to know fundamentals of physiology especially the physiology of movement and the physiologic effects of the various physical agents employed in medicine. d. pathology. A basic knowledge of pathology as related to physical medicine will be required and questions dealing with this subject will be included in the examination. e. other fundamental sciences. The applicant will be examined concerning his knowledge of such subjects as biochemistry and bacteriology as related to physical medicine.

B. The clinical aspects of physical medicine including: a. thermotherapy. The various clinical applications of heat and cold both locally and generally should be thoroughly familiar to the applicant. b. hydrotherapy. The methods of employing hydrotherapeutic devices and procedures will be covered in the examination. c. electrotherapy. Questions concerning clinical, diagnostic and therapeutic uses of the constant current, interrupted currents, sinudoidal and high frequency currents will be included in the examination. d. radiation therapy. The applicant will be examined specially concerning the diagnostic and therapeutic uses of ultraviolet and infrared radiation. (Applicants will not be required to answer questions concerning the therapeutic applications of roentgen rays and radium which are not included in the field of physical medicine but in the field of radiology.) e. kinesitherapy. Questions concerning the clinical uses of therapeutic exercise and massage will be included in the examination. f. occupational therapy. The applicant will be expected to answer questions concerning the indications for, and clinical applications of, various types of occupational therapy. g. physical rehabilitation. Because of the importance of the understanding of the philosophy of convalescent reconditioning and rehabilitation of the seriously disabled person, the applicant will be expected to have a thorough knowledge of the modern developments in these phases of physical medicine.

EXHIBIT ON PHYSICAL MEDICINE

At the centennial annual meeting of the American Medical Association at Atlantic City, N. J., the special exhibit on physical medicine was one of the outstanding features. It was in a key location on the center of the stage, the nine booths extending across the entire platform. Most of the essential features of physical medicine and rehabilitation of the physically disabled were brought to the attention of the approximately 6,000 physicians who visited the exhibit.

In the first booth the fundamental background of physical medicine, biophysics, was emphasized and the importance of technical knowledge stressed. The second booth illustrated the importance of experimental research by

accurate measurements with particular attention to microwaves. Clinical research was illustrated in the third booth. In the remaining sections the subjects of physical reconditioning, physical rehabilitation for neurological disabilities, poliomyelitis, cerebral palsy, arthritis and amputees were described including actual demonstration of treatment on patients.

The committee, consisting of Dr. Frank H. Krusen, Dr. Winfred Overholser, Dr. Howard Rusk, and the large numbers of physicians and technicians participating are to be congratulated on their excellent work which clearly demonstrated the importance of physical medicine in general medical practice and its position as a distinct specialty.

DR. MARY L. H. ARNOLD SNOW

One of the few pioneers among women physicians in physical medicine, Dr. Mary L. H. Arnold Snow, died on July 11, 1947, after a long illness, in the Greene County Memorial Hospital, Catskill, N. Y. Dr. Snow was born in Stockton, Cal., in 1867, and taught at the State Normal School there before she graduated as a physician from Cooper Medical College, Cal., in 1897. Coming east Dr. Arnold became the wife and associate in practice of the late William Benham Snow in New York City. In this city she practiced, taught and wrote on physical and x-ray therapy, until ten years ago. Early this century she was assistant in the Department of Electrotherapeutics and Diseases of the Nervous System at the New York Post Graduate Medical School, together with Dr. William B. Snow; she was also Professor of Mechanical Vibration in the New York School of Physical Therapeutics and associate editor of the *Journal of Advanced Therapeutics*, the forerunner of the *American Journal of Electrotherapeutics*. In 1912 she published a book, "Mechanical Vibration and Its Physiological Application in Therapeutics." After the passing of her husband she carried the editorship of the *American Journal of Electrotherapeutics*, later *Physical Therapeutics* until 1933, when the American Physical Therapy Association amalgamated with the American Congress of Physical Therapy and its Journal was purchased from the Snow family. Dr. Arnold Snow was at that time elected a life long member of the Congress. She was also a founder member of the New York Physical Therapy Society since 1921. Ten years ago she retired to Wyndham, Greene County, N. Y. Dr. Mary Arnold Snow was a lady of great personal charm, of extreme kindness to her patients and of exceptional courtesy to her medical colleagues. As the devoted wife of Dr. Wm. Benham Snow, she was at times almost self-effacing in cooperating with his teaching activities and practice. She is survived by their daughter, Mrs. Gordon B. Woolley of New York.

FAMED RADIOLOGIST DIES

Dr. F. Howard Humphris, distinguished radiologist died at Bath, England, June 17, at the age of 81. Francis Howard Humphris was an outstanding gentleman, scholar and gourmet. In the early part of his medical career he was court physician to the Queen of the Hawaiian Islands. After ten years in Hawaii he traded his practice with a Dr. Dobie in London and on the way back to England he stopped in New York where he and Mrs. Humphris lived at the home of Dr. Edward C. Titus, one of the pioneers in radiology and electrology. Although Dr. Humphris had done some of his work in Honolulu it was then that he successfully studied these two fields and prepared himself for the distin-

guished career he followed as a specialist in London.

During World War I, Major Humphris was the Chief of the X-Ray Department in an Army hospital in Cairo, Egypt, and after the war he established an office in the fashionable Mayfair district of London. His office in a large house was completely equipped for every phase of X-Ray work and all forms of electrotherapy. In his consulting room he always kept an apparatus for giving ether anesthesia although he never used it. He said that he had this machine on view so that people would know that he had an M.D. degree which he gained at the University of Brussels. There were few people in London who knew more about the serving of meals and fine wines than Dr. Humphris and he enjoyed personally brewing coffee at his dinner table.

Professionally his practice was limited to the fashionable class in London and he occasionally was visited by members of the Royal Family. He told the narrator that he had almost completely to transform his office on one occasion because a large piece of apparatus he wished to use in treating Edward, the Prince of Wales, was on the second floor and his Majesty would not try to walk upstairs to be treated.

Dr. Humphris was one of the early writers in modern physical therapy and always kept his original book up to date by bringing out subsequent editions. He was the guest of honor at the convention of the American Congress of Physical Medicine that was held at the Hotel New Yorker, some years ago. Among the scientific and academic honors achieved by him, the one most prized by him was the Golden Key of Merit of our Congress. We extend our condolence to his family in the sense of having lost a beloved member and comrade.

NORMAN E. TITUS, M.D.

PROGRESS REPORTS

Physical Medicine in the Navy*

By Commander Harry S. Etter (MC), U. S. N.

The topic of this paper has been an often discussed and cussed subject in many professional circles for several years. Whether or not all of the criticism has been justified, I do not intend to debate. Suffice it to say that physical medicine has progressed steadily in the Navy since 1941 and is continuing to progress. It is true that at times this progress has seemed slow and undramatic, but it is felt that this very slowness has been of distinct benefit to the long-range program for the Navy. I say this because those officers who planned and developed the program during the past several years planned it not only for the immediate present at that time but also for the future. Consequently, the facilities developed and plans formulated can now be readily adjusted to our peacetime needs with little waste or effort. In other words, all our "war profits" can be used for the foundation of our postwar operations.

That this reconversion period we are now passing through has not been without its difficulties, however, is self-evident. Equipment and facilities are most adequate. But the personnel situation, however, is another matter. Since the completion of demobilization, personnel shortages have existed in many places. It will take a little time to remedy these, but, with the development of our training program, it is expected that these deficiencies will be shortly overcome. In the meantime all phases of physical medicine will be continued on as high a professional level as is possible.

I shall have more to say about the training program and personnel requirements later. At this point, I should like

* Abstract of a paper read at the Twenty-Fourth Annual Meeting of the American Congress of Physical Medicine, New York, Sept. 5, 1946.

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to emphasize just what physical medicine means in the Navy. It means a separate and distinct clinical service composed of four independent but closely integrated subspecialties: physical therapy, occupational therapy, physical training and fever therapy. The functions of physical training are now largely being absorbed by the physical therapy branch, about which I shall have more to say shortly. Each of these specialties is considered to be of equal relative importance in the broad field of physical medicine, and all are directly under the supervision of the medical officer in charge of the physical medicine service. I emphasize this point because there are still many physicians in both naval medicine and civilian medical practice to whom the term "physical medicine" is synonymous with physical therapy only. This integration under one medical director is especially important as it relates to occupational therapy and the therapeutic aspects of physical training, for, if these two specialties are to be expected to retain their rightful war period importance, they must continue under trained medical supervision and be closely integrated with physical therapy.

This trained medical supervision is one of the weakest links in our physical medicine program at the present time. Although all individual departments are under the supervision of medical officers, there are only a relative few medical officers of the regular Naval Medical Corps who have received formal instruction in physiatry. All of these are currently assigned to duty in their specialty. It is planned to train additional medical officers in this specialty as rapidly as possible, and to this end two medical officers are being sent to a civilian institution for a twelve month period of instruction next month. This will still leave us very short of trained physiatrists, but these men will form the nucleus of a future larger group. It has been planned to train a considerably larger number immediately, but repeated requests for volunteers for this training have not produced the desired candidates.

This unresponsiveness on the part of the Medical Corps as a whole is probably due in no small part to the comparative newness of this specialty and to the lack of a certifying board in this field. In an attempt to increase interest and better acquaint all the younger medical officers with physical medicine, instruction in this specialty has recently been included in the curriculum of the basic course of indoctrination given at the Naval Medical School, Bethesda, Md. From now on the majority of medical officers coming into the Navy will be detailed to this basic course and will thus attain at least a little better understanding of this specialty. It is hoped that following this short indoctrination some of these men will desire to take further training in physiatry.

Although it is considered very important to insure skilled medical direction of the departments, it is considered equally important to staff the departments adequately with fully qualified physical therapists and occupational therapists. Plans have been made for this objective, which include a minimum of one qualified therapist in each specialty for every 500 hospital patients. Additional therapists will be assigned to special treatment hospitals, such as paraplegic, amputee and poliomyelitis centers. These qualified therapists will be supplied during the current year by those WAVE officers who have requested retention in the service until July 1, 1947, supplemented by civil service appointments and members of the Navy Nurse Corps. Approximately 25 WAVE officers in each specialty have had their applications approved for retention until July, 1947, and these therapists will all be assigned duties in naval hospitals in connection with physical therapy and occupational therapy departments.

In addition, funds have been allocated to provide for 50 qualified therapists in each specialty to be employed in a civil service status at P1 to P3 grades to augment these retained WAVE officers. The applications for these positions must be approved by the Rehabilitation Branch, Bureau of Medicine and Surgery, before final appointment is made. All applications are originally made, however, to the local labor board of the hospital concerned. All these personnel must be graduates of approved schools of physical therapy or occupational therapy, with registration and membership in the American Physiotherapy Association or the American Occupational Therapy Association as prerequisites for employment.

Although it is considered desirable from an administrative standpoint and for local hospital relations to have all these personnel in the uniform of the service, a sufficient number of retained WAVE officers are not available and an adequate number of nurses cannot be trained in time to replace the discharged WAVE officers to make this possible. This statement is not meant in any way as a criticism of civil service positions. It is meant only as an expression of my conviction that, since all of these positions have previously been filled by active service personnel, the transition period would have been easier if all therapists were familiar with naval policies and procedures. A precedent had been established that thera-

pists were officers, and now another precedent must be established to fill some of these positions with civilian employees. It is confidently felt, however, that the plan will work out very satisfactorily after a few wrinkles have been ironed out.

Because of the stated desirability of having active duty personnel perform the duties of physical therapists and occupational therapists in naval hospitals and because of the undetermined future of the WAVE Corps, both as regards a permanent organization and size if permanent, a long-range training program for members of the Navy Nurse Corps has been instituted. Eighteen nurses have recently completed a Council-approved six-month period of instruction in physical therapy at the Baruch Center of Physical Medicine, Medical College of Virginia, Richmond, Va., and are now taking their required clinical apprenticeship in three selected naval hospitals. This period of training fully qualifies the nurses as eligible for registry and for membership in the American Physiotherapy Association. In September, 1947 an additional 18 nurses were enrolled at the Medical College of Virginia for a regular nine month course of instruction in physical therapy, followed by a three month clinical apprenticeship, and 10 nurses will be similarly trained annually thereafter at undetermined approved schools until the necessary number have been trained to take care of the attrition rate and to fill the needs of the service.

All nurses assigned to this training volunteer for the training and are carefully screened as to past record and aptitude for the work, and all must agree to remain in the naval service for a minimum period of two years following the completion of the training.

A similar training program was started this same month in occupational therapy, with 18 nurses enrolled in the Philadelphia School of Occupational Therapy, and 18 in the Boston School of Occupational Therapy for the approved advanced standing course of eighteen months' duration. The students will be affiliated with the schools for this entire period of training, including the required apprenticeship training in civilian hospitals. Successful completion of this training will entitle the graduates to take the examination for registry in the American Occupational Therapy Association. All trainees assigned to the course request the training and are carefully screened before assignment as to educational background and aptitude for this work. All graduates also must agree to remain in the naval service for a minimum period of two years following the completion of the training. Ten additional nurses will be similarly trained annually after this year at these or other approved schools to take care of the attrition rate and until the necessary number to meet the needs of the service are obtained.

In addition to the registered therapists in the ratios previously indicated, it is necessary to augment the staffs of the departments with trained enlisted technicians in both physical therapy and occupational therapy in an approximate ratio of a minimum of three enlisted technicians in physical therapy and physical training for every 500 hospital patients and two enlisted technicians in occupational therapy for every 500 hospital patients. In order to provide as well trained assistants as possible for these specialties, a course in physical medicine has been established at the Naval Medical School, Bethesda, Md., under the full-time direction of a medical officer trained in physical medicine. The staff of the school includes registered therapists in both physical therapy and occupational therapy and personnel with training in physical education. Eight hundred hours of instruction is included in the curriculum. The first six weeks of the course is devoted entirely to instruction in the basic sciences, including anatomy, physiology, pathology, neurology, physics, kinesiology and psychology and psychiatry. All students detailed to the course take these basic subjects together, followed by joint instruction in the fundamentals of both physical therapy and occupational therapy technics. At the time that this period of training is completed, their proficiency and aptitude for either of these specialties can best be determined, and the initial group is divided into two groups, one of which specializes in physical therapy and the other in occupational therapy. In this way each group receives enough instruction in the other specialty to give them a sound foundation in both fields. This is considered to be highly desirable and should effect close cooperation between the respective departments.

Through mutual arrangements with the physical therapy and occupational therapy departments at the Naval Hospital, Bethesda, Md., the students also receive approximately six weeks of supervised clinical practice before graduation. The first group of 47 graduates recently finished the initial course of instruction, and approximately 55 additional students will be assigned to the course every six months from now on. These enlisted technicians after graduation will work only under the direct supervision of the qualified therapists when detailed to our naval hospitals. It is felt, however, that they will also be fully prepared to carry out the basic practical applications of physical medicine that

may be indicated when they are on duty afloat, with amphibious forces, or on isolated shore stations where it is not practical or considered necessary to maintain fully qualified therapists.

I am sure that all of you are familiar with the excellent work that was done in our Navy hospitals during the war by our physical training personnel. These officers and enlisted men all had fine physical education backgrounds, with a bachelor's degree in physical education as a prerequisite to assignment to the hospital program. In addition, they were all assigned to a special course in rehabilitation procedures, which included a review of anatomy and kinesiology, previous to their being detailed to hospitals. In the hospital organization they worked under the direction of the officer in charge of the physical medicine service or under the rehabilitation Officer—in other words, under medical supervision. You will remember that I previously included physical training as one of the four subspecialties of physical medicine. It was their responsibility to supervise the routine exercise program for every hospital patient, from the earliest practicable time that exercise could be prescribed by the ward medical officer while the patient was still confined to bed until the patient was discharged from the hospital. With many of our larger hospitals at one time carrying a census of well over 2,000 patients, this was obviously a tremendous assignment and one that certainly could not have been accomplished by the limited number of physical therapy personnell available. In addition, in many instances these men displayed an amazing aptitude for skilfully handling patients and inciting in the patients an intense desire to recuperate as rapidly as possible. In fact, in several outstanding instances they demonstrated a better approach and adeptness in the supervision of strictly therapeutid exercises than did the qualified therapists. It is well realized that their medical background was distinctly limited and their understanding of pathologic processes poor, but these shortcomings were frequently overcome by conscientious study on their part and assiduous attention to the restrictions imposed by necessarily close medical supervision. In fact, in several of our paraplegic centers these personnel have supervised the routine exercise program practically 100 per cent, and the excellent results that have been obtained in these cases certainly stand as a testimonial to the fine services that they have rendered.

With the completion of demobilization, however, all these physical training personnel have been separated from the service, and it is now planned that those hospital corpsmen specializing in physical therapy in the course previously described will conduct those phases of physical training which have proved to have definite therapeutic value. The extensive scope of the physical training program as we previously knew it will of necessity be greatly limited, but many of its features will in this way be able to be continued. And it is felt that this is exactly as it should be, because exercise in all its phases rightfully is an integral professional part of physical therapy and occupational therapy and should be supervised by these trained personnel. In this respect, I should like to interject a word of personal concern. Physical education personnel during this war have at times demonstrated an ability to conduct certain essential types of exercise more skilfully than our qualified therapists. If we do not profit by these lessons, one of these days we are going to find some pretty powerful agitation for another medical professional organization —physical training, reconditioning, or call it what you will. And I do not think that this would be at all desirable or necessary from either an economic or a professional standpoint.

In an attempt better to train our enlisted physical therapy technicians in these principles, we have included a total of 45 hours of didactic instruction and 121 hours of practical instruction in strictly physical training technics. Included are instruction in aquatics, games of high and low organization, dual and single sports and general calisthenics. These courses are designed to emphasize the importance of active exercise and its use as related to naval hospitals and are in addition to the course of instruction in therapeutic exercise. We feel that, as a result of the lessons learned in the management of our war casualties, more and more emphasis must be placed on the value of properly administered exercise technics. With apologies to the Army, reconditioning and not deconditioning must continue to be an essential part of hospital treatment, and exercise is the keynote of this program.

Very little has been said concerning fever therapy up to this point, but this is also an accepted part of physical medicine in the Navy in the larger hospitals, where the services of medical officers trained in this specialty are available. Short treatments at low temperature have continued to be of value in the management of certain types of arthritis, while sustained temperature of 105 to 106 F. are used routinely in the treatment of syphilis of the central nervous system in conjunction with penicillin, of nonspecific iritis and other miscellaneous conditions. The usual routine

care, both before and after the fever, is followed in all these cases. Demerol has been found to be a most excellent and safe sedative to use in conjunction with fever therapy. It is easy to use, has not been found to depress respiration and produces the desired sedative effect in practically all cases. In addition, it can also be safely used intravenously in suddenly hyperexcitable patients.

A special course of instruction of four months' duration is given to hospital corpsmen in fever therapy technics. All treatments, however, are given only under the immediate and constant supervision of a medical officer.

Research in the field of physical medicine in the Navy has been limited but has been conducted to the extent that time and personnel has permitted. It is hoped that this important phase will be expanded in the future. Several projects completed or still being investigated include a study of the effects of high frequency currents on tissues contiguous to implanted surgical metals, an evaluation of the use of prostigmine in conjunction with physical therapy in the treatment of certain neuromuscular disorders and studies of muscle action in health and in neuromuscular dysfunctions.

In conclusion, I should like to extend the Navy's appreciation and thanks to the American Congress of Physical Medicine, to the American Physiotherapy Association and to the American Occupational Therapy Association for the help and assistance that they have so generously given to us at all times in developing our program. This support has played no small part in helping to establish physical medicine on the high professional level that it enjoys today in the Navy. There is every reason to believe that these attainments will be continued.

MEDICAL NEWS

Dr. Kovacs Honored

Dr. Richard Kovacs has received word from Lord Horder, President of the British Association of Physical Medicine that the Council of the British Association of Physical Medicine has elected Dr. Kovacs as an Honorary Member of that Association as a mark of appreciation of the valuable contributions he has brought to Physical Medicine.

Residencies Available at New Institute of Rehabilitation and Physical Medicine

A new department has been established in Bellevue Hospital known as the Department of Rehabilitation and Physical Medicine. It is one of the major specialty services in the hospital, and is under the direction of the Department of Rehabilitation and Physical Medicine of the New York University College of Medicine.

There are two special rehabilitation wards at Bellevue with a capacity of 80 patients, and with special remedial gymnasia, rooms for elevation activities, occupational and physical therapy departments and outpatients service as part of the total unit.

At present there are the following vacancies:

Two Internships. Salary $540.00 annually, plus maintenance. (One year's hospital service required.)

Three Assistant Residencies. Salary $840.00 annually, plus maintenance. (Minimum of one year's hospital service required.)

One Residency. Salary $1,440.00 annually, plus maintenance. (Minimum of two years' hospital service required.)

In the Fall there will also be two Baruch Fellowships available in Rehabilitation and Physical Medicine at $1,500.00 annually.

The Rehabilitation service is the first of its kind in any general hospital and medical school and has been established at a cost of $250,000. It is designed to help the patient from the bed to the job. It consists of training and experience in modalities of physical medicine, corrective physical reeducation, rehabilitation, management of chronic diseases and experience in the out-patient and admitting service. The service will include the rehabilitation problems involved in paraplegia, hemiplegia, infantile paralysis, cardiac disease, cerebral palsy, arthritis, etc.

Pennsylvania Academy of Physical Medicine

At a regular monthly meeting of the Pennsylvania Academy of Physical Medicine, June 19, 1947 at the Philadelphia County Medical Society Building, a symposium on backache was presented by Dr. Harry Tumen, Philadelphia, on the medical aspects; Dr. Michael Scott, Philadelphia, on the neurosurgical aspects and Dr. A. Rechtmann, Philadelphia, on the orthopedic aspects.

The following officers were elected for the ensuing year:

President — Dr. Harold Lefkoe, Philadelphia.

Vice-President — Dr. William Schmidt, Philadelphia.

Secretary — Dr. Herman L. Rudolph, Reading.

Treasurer — Dr. J. H. Hennemuth, Emmaus.

Chairman Program Committee — Dr. George Piersol, Philadelphia.

Occupational Therapy Teaching Center

Wayne University College of Medicine, Detroit, announces the opening of a new teaching center in Grace Hospital for its occupational therapy curriculum. Although the curriculum utilizes the facilities of three of Wayne's colleges and many of Detroit's clinical training facilities, the professional training itself will be offered at the new center. Medical phases of the instruction are to be directed by Dr. Max K. Newman, a psychiatrist at the hospital and a member of the Wayne faculty of medicine.

Philip L. Stanton Becomes General Manager

Announcement is made of the appointment of Mr. Philip L. Stanton as General Manager of the E & J Manufacturing Company, manufacturers of the E & J Resuscitator, with headquarters in Glendale, California. Mr. Stanton has been associated with the E & J Manufacturing Company for the past fourteen years as Manager of the E & J Company of Pennsylvania, in Philadelphia. An important program of expansion in plant facilities and new products is in progress at the E & J plant in Glendale. Mr. Leon F. Weckerly succeeds Mr. Stanton as Manager of the E & J Company of Pennsylvania.

Annual Report Baruch Committee on Physical Medicine

Increased opportunities in rehabilitation for the 23,000,000 Americans disabled by accident, disease, maladjustment and war, were forecast in the annual report of the Baruch Committee on Physical Medicine. The advancements in physical medicine and rehabilitation in the period covered by the report were termed of real significance in medical history by the committee composed of leading physicians and medical educators.

The report was prepared for Mr. Bernard M. Baruch, elder statesman and philanthropist who established the committee in 1944 with a grant of one and one-quarter million dollars. Major objectives of Mr. Baruch in founding the committee were to further research training and teaching in physical medicine, and to translate the wartime lessons learned in rehabilitation of disabled veterans to the far greater number of handicapped civilians in need of such care.

Particular emphasis is being laid by the committee on research in the science of hydrology, the therapeutic use of water, a field in which Mr. Baruch's father, Dr. Simon Baruch, as the first professor of hydrology at Columbia University, was one of the original pioneers of this country.

The publication in addition to reporting general advancements in physical medicine outlined current research and training being carried on in twelve leading medical colleges in the utilization of the science of physics therapeutically through the use of cold, heat, light, water, electricity, massage, muscular education, therapeutic exercise and physical rehabilitation.

In issuing the report, Dr. Ray Lyman Wilbur, Chancellor of Stanford University and Chairman of the Committee, and Dr. Frank H. Krusen, of the Mayo Clinic, Director of the Committee, pointed out that, although even primitive man recognized that such of the physical agents as he knew affected him physiologically, the specialty of physical medicine is only now being recognized as an important and integral part of medical science. Much of this recognition they credited to the work of the Baruch Committee and cited as evidence a recent survey of 105 physicians specializing in physical medicine who directly attributed the great majority of the recent advances in this field to the work of the Baruch Committee.

One of the most significant items in the report was the announcement that the Advisory Board of Medical Specialties has approved the establishment of an American Board of Physical Medicine which will qualify physicians as specialists in this field of medical practice. Such specialists will be known as "physiatrists," a designation which stems from the Greek words "physis" referring to physical phenomena or agents and "iatreia" referring to a physician or healer. The term, which was recommended by the committee, has been adopted by the Council on Physical Medicine of the American Medical Association, the American Congress of Physical Medicine, and the Society of Physical Medicine.

Among the projects sponsored by the committee from which the physically disabled are receiving immediate benefits are three centers for physical medicine and rehabilitation at Columbia University, New York University and the Medical College of Virginia, recipients of grants totalling $900,000. The three centers, which are being developed over a ten year period, are designed to serve as models for medical schools and hospitals both in this country and abroad.

Benefits to the disabled will also come from the training of physicians and other personnel in physical medicine and rehabilitation and from research now being conducted under grants from the committee in nine other leading universities. Among these schools are Massachusetts Institute of Technology, Harvard University, University of Minnesota, University of Southern California, University of Iowa, Marquette University, Washington University and the University of Illinois. A similar program is to be started soon at George Washington University School of Medicine.

In addition to financial support for research and training, the Baruch Committee furnishes professional consultation and advice to the universities participating in its program through its Scientific Advisory Committee consisting of Dr. Frank H. Krusen, Mayo Foundation, University of Minnesota, Chairman; Dr. John Stanley Coulter, Northwestern University; Dr. John F. Fulton, Yale University; Dr. Charles Gordon Heyd, Columbia University; Dr. Andrew C. Ivy, University of Illinois; Dr. Chauncey D. Leake, University of Texas; Dr. Frank R. Ober, Harvard University; Dr. Winfred Overholser, St. Elizabeths Hospital, Washington, D. C.; Dr. Francis O. Schmitt, Massachusetts Institute of Technology, and Dr. William S. Tillett, New York University.

Among the other activities of the committee have been the publication of a report on "A Community Rehabilitation Service and Center" as a basic guide to assist communities planning to establish rehabilitation services; numerous scientific exhibits at medical meetings; the granting of 23 fellowships in physical medicine, five of which are Baruch Military Fellowships given to Army and Navy physicians, one fellowship in occupational therapy, and one fellowship in physical therapy; a grant to the American Association of Physics Teachers for a study on the teaching of physics as related to medicine and pre-medical training; and the establishment of a subcommittee to evaluate physical fitness.

A special exhibit on physical medicine was sponsored by the committee at the Centennial of the American Medical Association in Atlantic City. The exhibit which was seen by some 15,000 physicians included both technical, experimental and clinical research in physical medicine and "real life" demonstrations in methods of rehabilitating arthritics, paralytics, amputees, and victims of poliomyelitis, and cerebral palsy.

Medical School at the University of Wisconsin Presents Intensive Course in Care of Infantile Paralysis

The Medical School of the University of Wisconsin presented an intensive course in the care and treatment of Infantile Paralysis, during the weeks of June 23 and July 26 at the Medical School and the State of Wisconsin General Hospital and Orthopedic Hospital in Madison. This was conducted in conjunction with the National Foundation for Infantile Paralysis, Inc., as well as the Wisconsin State Organization.

Enrollment was limited to physicians from the local communities throughout the State of Wisconsin and the physicians who were selected by the Infantile Paralysis Organizations throughout the state. The diagnosis of the disease and the immediate care of the patient were emphasized.

Minimum Requirements for Acceptable Electrocardiographs

1. The electrocardiographs shall be equipped with a suitable recording mechanism.

2. The recorded response of the instrument to externally applied square wave voltages shall be adjustable to a sensitivity of 1 cm. per millivolt when this voltage is applied to the leads of the instrument through a series resistance of 2,000 ohms. This sensitivity shall be maintained without further adjustment within ± 5 per cent for a period of thirty minutes under operating conditions. Operating conditions for the purpose of this requirement are defined as (1) for alternating current operated instruments as line voltages varying from 105 to 130 volts at frequencies within ± 2 per cent of the specified value for the instrument, (2) for battery operation as one or more of the batteries operating at 80 per cent of the rated life or voltage whichever condition occurs first. Under these conditions the response of the instrument to its incorporated standardizing signal of 1 millivolt shall be within ± 5 per cent of the response to the externally applied test signal. The instrument shall incorporate means of superimposing its intrinsic test signal into the cardiographic tracings as recorded from any lead position. It should be possible to maintain this test signal voltage for a period of two or more seconds.

3. The amplitude response of the instrument to 1 millivolt peak sinusoidal voltage variation up to 15 cycles per second shall not fall below 90 per cent, and up to 40 cycles shall not fall below 50 per cent of the square wave response to equivalent voltage variations. The amplitude response of the instrument to 1 millivolt peak sinusoidal voltage variation up to 300 cycles per second shall not exceed 100 per cent of the square response to equivalent voltage variations.

4. The response of the instrument at 0.2 second after the application of a direct current of 1.0 millivolt shall not deviate more than ± 10 per cent from the response at 0.04 second. The test voltage of 1 millivolt should be applied to the leads of the instrument through a series resistance of 2,000 ohms.

5. When the instrument is adjusted to the sensitivity specified in requirement 2 the recorded response shall be directly proportional to the applied voltage (direct current) within ± 5 per cent over a range of 2 cm. on either side of zero.

6. With the two input terminals connected together, a potential difference applied between them and ground should not produce a deflection of more than 1 per cent of that produced by the same potential difference applied between the two input terminals.

7. The instrument shall incorporate a means of continuously recording time intervals on the record. These intervals shall be of one second duration or less and shall be accurate within ± 2 per cent. A means of superimposing this time signal on the electrocardiographic tracing at the operator's will will be accepted as fulfilling this requirement. It should be possible to record the time signal for a period of at least two seconds. Recording paper preruled so as to indicate time intervals, assuming a constant paper speed, shall not be construed as fulfilling this requirement.

8. The construction of the instrument shall be such as to meet the shock hazard requirements of the Underwriters' Laboratories, Inc.

9. Instruments shall be submitted and considered according to the Official Rules of the Council on Physical Medicine.

10. The standards of merchandising and the acceptability of advertising shall meet the Rules of the Council on Physical Medicine. — J. A. M. A. 134:455 (May 31) 1947.

Dr. Jacques Goldberger

We regret to announce the passing of one of our Congress members, Dr. Jacques Goldberger, of New York City.

BOOK REVIEWS

X-RAY DIFFRACTION STUDIES IN BIOLOGY AND MEDICINE. By *Mona Spiegel-Adolf,* M.D., Professor of Colloid Chemistry and Head of the Department of Colloid Chemistry, Temple University School of Medicine and *George C. Henny,* M.S., M.D., Professor of Medical Physics and Head of the Department of Physics, Temple University School of Medicine. Cloth. Price, $5.50. Pp. 215 with 86 illustrations. New York: Grune & Stratton, 1947.

The importance of x-ray diffraction work in the analysis of the finer structure of biological tissues is at present self evident. Work of this kind has contributed enormously and will in the future contribute even more to our knowledge of the ultimate structure of living matter. It is this sort of knowledge that is the fundamtal basis for an appreciation of the physiology of the tissues involved. It is, of course, an undisputed fact that work of this kind involves one of the fundamental technics of biophysical research. It also goes without saying that the authors are extremely well qualified to write a book like this, as many of the most important contributions in this field come from their laboratories. There are, however, a number of books in this field in which the researcher can find most of the data which he might need. These books, however, are written for physicists and specialists in the field. The present authors have set out to write a book that is of interest to the average biophysicist or physiatrist not a specialist in this particular field but who needs to interpretate and use the data obtained with x-ray diffraction methods for his own research in biophysics and physical medicine. It is no easy task to analyze work of this kind in such a way that the average biophysicist can understand and digest it without becoming so elementary that the material becomes superficial and useless. It is the opinion of this reviewer that the authors have succeeded remarkably well in this difficult task. The book gives a clear description of what the x-ray diffraction patterns mean and what their relation is to data obtained in other ways. Comparison of x-ray data and electron microscope and electron diffraction data is made. The book begins with the theory of x-ray diffraction which is followed by a description of apparatus and technics. Commercial apparatus is described but the authors also will make many thankful readers with the description of the apparatus which they build in their own laboratory and which appears to be more within the reach of the average scientific budget. The book then describes studies on carbohydrates, amino acids and proteins, on nucleoproteins, lipids and steroids. The x-ray patterns of muscles, bones and nerves are discussed in separate chapters. In the chapter on muscle such topics as the influence of muscle stimuli on the diffraction pattern and some drugs and ions are mentioned. In the chapter on nerve the question of the structure of the axis cylinder and the influence of chemical agents is discussed. In these chapters the authors have limited themselves to a very brief discussion of the results obtained and their significance. However, each chapter is followed by a list of references which make further study possible. The text has been illustrated throughout with clear illustrations. By the exercise of due restraint in the extent of the discussions and by careful selection of material, together with well chosen references the authors have managed to give the nonspecialist reader a clear picture of the value of x-ray diffraction studies. In reading this book one gets the impression of being guided through a difficult field by two competent guides who have set out to demonstrate the value of this work in the general pattern of biophysics, rather than crowd the nonspecialist with a lot of unwanted detail. The book is a valuable contribution.

A HISTORY OF THE AMERICAN MEDICAL ASSOCIATION, 1847-1947. By *Morris Fishbein,* M.D., with the Biographies of the Presidents of the Association by *Walter L. Bierring,* M.D., and with Histories of the Publications, Councils, Bureaus, and Other Official Bodies. Cloth. Pp. 1226. Price, $10.00. Philadelphia and London: W. B. Saunders Co., 1947.

This is the complete 100-Year history of the American Medical Association. The data presented was drawn from the Official Transactions of the Association; official proceedings of the House of Delegates; Minutes of Meetings of the Board of Trustees; official correspondence of the Association. This book should be in the library of all medical and scientific societies.

THE CARE OF THE NEUROSURGICAL PATIENT BEFORE, DURING AND AFTER OPERATION. By *Ernest Sachs,* A.B., M.D., Professor of Clinical Neurological Surgery, Washington University School of Medicine, Saint Louis, Fabrikoid. Price, $6.00. Pp. 268, with 177 illustrations including two in color. St. Louis: The C. V. Mosby Company, 1945.

This small monograph was written primarily for the purpose of teaching preoperative and postoperative care of neurosurgical patients. The book gives details of adequate care of neurosurgical patients based on the experience of the author during the past thirty-six years. It was written in the hope that it might be of benefit both to house officers and to the rapidly growing number of students who are preparing to be neurosurgeons.

The book consists of nine chapters. In the first chapter the author discusses the preoperative examination and care of the patient, including consideration of many procedures and diagnosis. The second chapter is concerned with the operating rooms, preparation of the patient and of the operating team and the general operative procedures; chapter three, with anesthesia; chapter four, with neurosurgical methods such as control of hemorrhage, suction, gauze, cotton and bone wax, instruments used in neurosurgical work, types of cranial incision and ventriculography. In chapter five, cranial lesions and the operative procedures used in their treatment are described. The areas of operation are discussed. Spinal and peripheral nerve operations such as laminectomy, chordotomy, operations for treatment of spina bifida and dislocated nucleus pulposus and peripheral nerve operations are considered in chapter six. In chapter seven, a description of the technic of the closure of wounds is presented. In chapter eight, the postoperative care, the position of the patient in bed, postoperative blood clots and fever, care of the bladder and bowels, feeding of patients, significance of headaches and technic of applying surgical dressings are discussed. The last chapter is a review of neurosurgery and a glimpse into its future.

The book is well illustrated and should be of interest to the young neurosurgeon.

MEDICAL PHYSICAL EDUCATION. By *Fred John Lipovetz.* Revised edition. Paper bound, mimeographed. Price, $4.00. Pp. 417 with illustrations. Burgess Publishing Co., 426 South Sixth Street, Minneapolis 15, Minnesota, 1946.

This mimeographed paper bound volume was written primarily for the purpose of teaching instructors in physical education. It is divided into three main sections. The first section, "Applied kinesiology," is a discussion of bodily mechanics, muscular action and analysis of movement. In an appendix to this section suggestions for teaching physical education and coaching athletics are made. The lever action of muscles and various exercises are illustrated by many line drawings. The section is concisely written and comprehensive. However, a surprising number of statements in regard to anatomy are quite contrary to those found in the standard textbooks of anatomy and in studies by well-known investigators in the field of functional anatomy.

The second section is entitled "The physiology of exercise." Such subjects as muscular structure and contraction; chemistry of muscle; the phenomenon of muscular action, control and movement; ascending and descending tracts of the spinal cord; classification of muscular control; equilibrium; postural tonus and tonus reflexes; nerve mechanism of the heart; innervation and chemistry of respiration; localization of cerebral function and process of learning; definition, classification and comparison of exercises; the general effects of muscular exercise; effects of special types of exercises upon bodily function; the role of the heart in physical education; age periods and physical educational objectives; muscular effort and physical efficiency tests, and physiologic experiments are discussed. This section is also quite comprehensive. It is unfortunate that despite the fact that the author has quoted extensively, he has not given references to recent studies — the most recent reference being to material written approximately twelve to fifteen years ago.

The final section is entitled "Physical diagnosis; corrective, remedial, and preventive physical education supplement." This section is divided into two parts; one is called "Physical diagnosis" under which anthropometric studies and subjects such as athletic injuries, function and diseases of lymph glands, thyroid gland, blood pressure and respiratory and circulatory systems are discussed. Most of the discussions under this section were written by physicians; one of the articles was written by an osteopathic practitioner. It is not made clear by whom the physical diagnosis should be made, the physical educationalist or the physician. A chart is presented showing the relationship between medicine, physical therapy and physical education. It is implied by this chart and partially by the discussion that physical therapy is the use of only thermotherapy, hydrotherapy and electrotherapy, whereas physical education consists of the use of corrective remedial and preventive exercises. The field of physical therapy is not clearly defined; neither is that of physical education.

The author had an excellent opportunity to compile a useful and valuable book for use in teaching both physical education and physical therapy. However, this opportunity seems to have been missed because the book contains errors and possibly some misinformation and because much of the material presented is not up to date. This book cannot be recommended highly as a teaching manual for either physical educationalists or physical therapists.

AGING SUCCESSFULLY. By *George Lawton.* Cloth. Price, $2.75. Pp. 265. Columbia University Press, 2960 Broadway, New York 27, 1946.

This is good reading for everyone and should appeal to the young who never believe that someday they will be old, to the so-called middle aged who fear they will be old and the really old who are certain. Much kind advice is given to all regardless of age. The manner of presentation is sensible and practical without the usual mawkish sentimentality. The author uses case histories to illustrate his ideas and has numerous quotations from famous and less famous individuals that are always appropriate and often humorous. The chapter "To Invite Trouble After Fifty," is poignant and briefly considers many items such as "get a wonderful cook, seek a scapegoat for your unhappiness, marry someone very much younger, demand respect and honor because you are old," etc. In the chapter, "A Man Grows Older" many statements are made which are not always complimentary but unfortunately true; the author's

understanding of the male personality is certainly correct. The purpose of the book is aptly expressed on the cover, "How to enjoy a rich, constructive life as you grow older: A book for everyone who will ever be 60, and for everyone who is, or has been 60."

BODY MECHANICS IN NURSING ARTS. By *Bernice Fash,* B.P.E., B.S., Instructor of Physical Education, Cook County School of Nursing, Chicago, Illinois. With a foreword by *Lucile Petry,* Editorial Advisor for McGraw-Hill Series in Nursing. First edition. Fabrikoid. Price, $2.75. Pp. 132. Profusely illustrated. New York and London: McGraw-Hill Book Company, Inc., 1946.

This book is a small monograph written for the purpose of teaching nurses the dynamic functions of the body in everyday activities. It is a new approach in the teaching of bodily mechanics to the nurse. An attempt is made to teach how to prevent strain and fatigue and to conserve energy while working. It is suggested that this instruction be given early in the nurse's training course in order that the nurse may learn to conserve energy and use good postural movements by the time she actually starts nursing practice.

The book is divided into three sections. In the first section the basic laws of physics are described in a nontechnical manner. Some of the various positions in which stress and fatigue may occur through the incorrect use and position of the upper and lower extremities and trunk of the body are illustrated by line drawings. Correct and incorrect positions for all the major movements in nursing are illustrated.

The next section contains many illustrations of the positions involved in the more strenuous activities of the nurse, such as turning and lifting of patients, giving them baths and shampoos and lifting them from bed to wheelchair. The author also stresses correct positions to be used by the nurse when she is charting, standing or sitting.

The third section is entitled, "Introduction to body mechanics in business and industry." It includes a working outline for typists, filing clerks, workers in industrial plants and students.

The book is well illustrated and simply written. Many important points in bodily mechanics are given. The book can be highly recommended for teaching student nurses and may be used to advantage by people in other professions or business.

THE SECOND FORTY YEARS. By *Edward J. Stieglitz,* M.S., M.D., F.A.C.P., with illustrations by *Ann Stieglitz.* Foreword by *Anton J. Carlson,* A.M., Ph.D., LL.D., M.D., ScD. Cloth. Pp. 317. Pdice, $2.95. Philadelphia: J. B. Lippincott Co., 1946.

Cultivation of those elements which can enrich our later years in the most effective way to a full life. But such development is not easy. Full, rich, fruitful lives in later maturity are not fortuitous; this book gives a volume of hints to make a planned effort. We cannot stop aging but we can grow older intelligently. It is impossible to solve all individual problems or even attempt answering all the innumerable questions which may arise. But this study makes available the fundamental data regarding the normal patterns of change and the more frequent hazards of senescence. With this knowledge and the will to make an effort much health, happiness and hope can be built into the second forty years.

The difference between the results of planned and cultivated senescence and the mere aging are essentially similar to the difference between a cultivated garden and a neglected one choked with weeds. Yield is directly proportional to cultivation. We may either just get older or we may grow older, remembering that growth can be made to mean progressive development.

A rich harvest in the second forty years is possible up to a point where true senility becomes infirmity. For convenience in discussion, we may divide the later half of life into three periods: Later maturity or early senescence (approximately forty to sixty years), late senescence (sixty to seventy-five) and senility (after seventy-five). True senility may be delayed until after eighty or even ninety. But such a result is not to be had for the mere asking; wishing alone does not suffice. Preparation, planning and push are required. The obligation to make such efforts is not purely a personal one. Efforts to maintain health and usefulness into the later years are obligations due to the family, the community and the nation.

Life has more than mere length. It also has depth and breath. One's productivity or usefulness is more nearly measured by depth and breath than by length alone. Mere continued existence to ripe or rotten old age, with many weary years of unnecessarily premature disability is certainly more hindrance than help to society. This book tells how to think properly about the mounting years and shows how an elderly person must strive a little harder and use more judgment in order to maintain a healthy mind and body.

LECTURES ON REGIONAL ORTHOPEDIC SURGERY AND FUNDAMENTAL ORTHOPEDIC PROBLEMS. Selected from the Instructional Courses of the Thirteenth Annual Assembly, Chicago, January 19-23, 1946. Edited by *James E. M. Thomson,* M.D., Lincoln, Nebraska, Chairman of the Instructional Section. Cloth. Price, $6.00. Pp. 249, illustrated. Ann Arbor: J. W. Edwards, 1947.

The publisher is to be complimented on the this publication. The editor has wisely selected the lectures and presentations of many of the participants at this orthopedic meeting and included the works and opinions of many of the outstanding orthopedic surgeons and other medical men interested in bone and joint diseases. The material covers the foot, ankle, hip and shoulder in a manner not found in the usual textbooks. The discussion includes the anatomy, pathology, symptoms and surgical treatment of the various disorders considered. Sections on infantile paralysis, cerebral palsy, club foot and fractures of the shaft of the femur are presented by short articles. It is interesting to note that in the article by Ghormley on "History of Treatment of Poliomyelitis,"

the word Kenny does not appear once although an entire paragraph is devoted to Dr. Jean McNamara of Melborune, Australia, and the article by Green entitled, "The Treatment of Infantile Paralysis," has only one reference to Kenny concerning the use of a foot board as a splint. There are also chapters on orthopedic x-ray, posture and a symposium on degenerative hip diseases.

The publisher is to be complimented on the excellence of the reproduction of the illustrations which are numerous and instructive.

Although this book should be most valuable to the orthopedic surgeon, it should also be of interest to physiatrists and those interested in physical medicine.

SYMPOSIA ON PRESENT DAY SOCIAL AND ECONOMIC ASPECTS OF NATIONAL HEALTH AND THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION, AND AMERICAN PARTICIPATION IN ITS ACTIVITIES. Paper. Price, $1.00. Pp. 66. Philadelphia: The American Philosophical Society, 1946.

Twelve papers read before the American Philosophical Society's Annual General Meeting in April, 1946. The first seven papers cover subjects dealing with public health and include Rehabilitation, by Rusk; Mental Hygiene, by Overholser; Public Health Experiences in the European Theater, by Draper and others. The last five articles concern the purposes and operations of UNESCO.

A DIRECTORY OF AGENCIES AND ORGANIZATIONS CONCERNED WITH REHABILITATION AND SERVICES TO THE HANDICAPPED. By *Howard A. Rusk*, M.D., and *Eugene J. Taylor*. Paper. Pp. 134. Price, 10 cents. New York: *The New York Times*, 1947.

MENTAL HYGIENE OF THE ORTHOPEDICALLY HANDICAPPED CHILD. By *E. Louise Ware*, Ph.D. Paper. Pp. 16. Price, 25 cents. New York 19, N. Y., Association for the Aid of Crippled Children, 580 4th Ave., 1947.

THE DIAGNOSIS AND TREATMENT OF ACUTE MEDICAL DISORDERS. By *Francis D. Murphy*, M.D., F.A.C.P., Professor and Head of the Department of Medicine, Marquette University School of Medicine and Clinical Director of the Milwaukee County General Hospital and Emergency Unit, Milwaukee, Wisconsin. With a foreword by *George Morris Piersol*, M.D. Second Edition. Cloth. Price, $6.50. Pp. 546, illustrated. Philadelphia: F. A. Davis Co., 1946.

This volume includes the latest advances in the diagnosis and treatment of the more common medical diseases and disorders encountered by the general practitioner. This type of book fulfills the needs of the busy physician who is confronted with acute problems in his daily practice. The author avoids lengthy consideration of etiology, pathology and controversial subjects. The discussion of the symptoms and the signs and the treatment are concise and needless words are avoided. The differential diagnosis is not exhaustive which is no doubt intentional in a volume which is meant to be practical. Differences in opinion are possible as for example the use of calomel and neoarshpenamine in malaria, the recommendation of "physiotherapeutic measures as passive exercise, massage, short wave and ultraviolet should be instituted when the acute phase (of neuritis) has passed," the inclusion of viosterol for the therapy of jaundice and a few others. The use of trade names for the various drugs might better have been avoided.

These minor errors do not detract from the value of the book and it can be recommended as a ready reference for the immediate care of acutely ill patients and for their subsequent convalescent management.

ESSENTIALS OF PEDIATRICS. By *Phillip C. Jeans*, A.B., M.D., Professor of Pediatrics, State University of Iowa, Iowa City; *Winifred Rand*, A.B., R.N., formerly specialist in Parental Education, Merrill-Palmer School, Detroit; Superintendent of Nurses, Director, Baby Hygiene Association, Boston; Director, Division of Child Hygiene, Community Health Association, Boston, and *Florence G. Blake*, R.N., M.A., Assistant Professor of Pediatric Nursing, Yale University School of Nursing. Fourth edition. Cloth. Price, $3.50. Pp. 627 with 86 illustrations and 9 subjects in color. Philadelphia, Montreal, London: J. B. Lippincott, 1946.

This is the fourth edition of a book which has been written primarily to be used as a textbook in pediatric nursing. In this edition the book has been completely rewritten and brought up to date and much new material has been added. Chapters on diseases of the eye, the blood and the glands of internal secretion have been added and also numerous additions to other chapters have been made. A discussion relative to problems of well baby clinics has been added in the chapter "Child health conferences as a means of guidance."

The first two units of the book are devoted to pediatric nursing, preventive pediatrics and to growth, hygiene and training of the infant. The third unit consists of a chapter discussing the nurse-child relationship, hospital admitting room, hospital ward and care of the child in the home.

The fourth unit consists of a discussion of diseases of the various systems of the body. In each of the chapters in this unit, after a concise description of the various diseases and their treatment, a carefully outlined discussion of the nursing care in each disease is given.

The last unit consists of several chapters on nutrition and nutritional diseases and the nursing problems arising in each of these diseases.

The book is well organized and concise and can be highly recommended for the purpose of teaching in nursing schools or for nurses interested in pediatric nursing.

PHYSICAL MEDICINE ABSTRACTS

Manipulation in General Practice. A. G. Timbrell Fisher.

Practitioner **945**:209 (March) 1947.

Treatment by manipulation of many chronic disabilities of the joints and spine and of the locomotor system generally, is often of the greatest value in carefully selected cases. The time-lag in the recognition of its value has been due to a number of factors, one of the principal of which has been the bad results often attending manipulations by unqualified practitioners and which far outweigh their occasional successes. The clinical and pathologic training that a qualified medical man receives should largely eliminate this objection. Another factor militating against the recognition of manipulative treatment has been the view that, owing to the acute reaction in the joint which is alleged to follow manipulation, more satisfactory results can be obtained by gradual methods, such as reeducational exercises, supplemented by physical treatment in such forms as heat, massage and electricity. Such methods are often of great value in minor cases of post-traumatic or rheumatic adhesions, or when used either as a preliminary or sequel to manipulation in more severe types of crippling. Exercises and physical methods have, however, their limitations; the practice of continuing with them indefinitely when progress is not being made and when residual stiffness might be speedily rectified by manipulation is not in the patient's best interests and is contrary to common sense. When the necessary knowledge and skill have been acquired and with careful selection of cases, postmanipulative reaction in a joint is a rare phenomenon and this bogey should not therefore be raised as an argument against manipulation when the ideal time for this has arrived.

The cases of articular or periarticular adhesions that respond best to manipulation are those which have brought about a slight or moderate degree of limitation of movement, associated with pain and/or swelling and which have failed to respond to ordinary methods of physical treatment. The art of manipulation does not consist solely in moving the joint through its full range of movement, as is sometimes asserted. There is a special technic for every joint and a famous bonesetter was not far wrong when he said, "It's the twist that does it."

Immersion Hypothermia. E. Wayburn.

Arch. Int. Med. **79**:77 (Jan.) 1947.

Wayburn describes observations on 6 patients who had been immersed in the North Sea on their return from long combat flying missions. Immersion hypothermia is a progressive clinical syndrome. The clinical picture is the resultant of the coldness of the water, the length of the exposure, the emotional factors affecting the patient before and during exposure and the specific response of the person to cold. The chief effects are those on the cardiovascular system. Among the transient conditions were auricular fibrillation and flutter, ventricular extrasystoles, slight prolongation of the PR interval and falling arterial blood pressure, with narrowing of the pulse pressure. Involvement of the nervous system was indicated by partial to complete loss of consciousness and irrational behavior. Hemoconcentration and notable hyperglycemia were found in 1 case.

A Few Essentials in Prescribing Physical Medicine in General Practice. Earl C. Elkins.

Jr. Lancet **67**:97 (March) 1947.

Physical medicine may be defined as the employment of physical and other effective properties of light, heat, cold, water, electricity, massage, manipulation, exercise and mechanical devices for diagnosis or physical and occupational treatment of disease. To prescribe physical medicine properly, a physician should know the basic physical principles involved, the physiologic effects of the agents and the procedures to be used, the agent or instrument most likely to be effective in each condition, how long these procedures should be used each day and which procedure should be used.

The physician should know the pathologic or functional changes in conditions to be treated and the individual tolerance of the patient. Undoubtedly, it will be years, if ever, before the exactness of dosage of the agents and procedures of physical medicine will be comparable to that of drugs.

The lack of exact knowledge of the effects of many agents relative to time, intensity and dose does not allow precise statements to be made. However, some of the factors which should be known in order to prescribe some of the most commonly used physical agents adequately were pointed out. These were discussed under the general headings of thermotherapy, massage and therapeutic exercise. Electrotherapy, other than the use of the high frequency currents for thermotherapy was not discussed.

Studies on the Motor Cells of the Spinal Cord V. Poliomyelitic Lesions in the Spinal Motor Nuclei in Acute Cases. H. Chandler Elliott.

Am. J. Path. **23**:313 (March) 1947.

The motor nuclei of the limbs were studied in cords from 25 human subjects who died from poliomyelitis. In agreement with an earlier paper, almost all lesions involved dorsal and medial nuclei and extended ventrolaterally only secondarily. Exceptions were found, but these were

rare and trivial. It was further found that caudal nuclei and one small dorsomedial group in the cervical region tend to survive. The probable presence and survival of marginal spinocerebellar cells in the ventral horns does not invalidate the observations. It is suggested that the differential infection of nuclei is due not to their proximity to a source of infection, nor to their own intrinsic susceptibility, but to passage of virus along tracts ending in certain nuclear groups, e. g., those controlling muscles involved in decerebrate rigidity, in the flexor reflex. As few as one or two foci of invasion may be found in a fatal case. Thus the virus may find sufficient passage in a single fiber. The importance of clarifying neuromuscular relations, in order that the observations may be applied clinically, is emphasized.

The Treatment of Simple and Comminuted Fractures of the Head of the Radius. C. B. Buffington.

West Virginia M. J. 43:198 (June) 1947.

Following aspiration, the arm is carried in a sling for three to five days. The patient is instructed to remove the sling and carry out all motions of the joint to the point of pain four times a day, but emphasis is placed on the fact that the arm should be left at rest the remainder of the time. The use of ice packs the first day or so and then heat does not seem to influence the result. All cases should be seen daily for the first week. If limitation of motion and pain recur, aspiration should be repeated. Some cases may need to be aspirated three times. Each subsequent aspiration will yield proportionately less blood.

The Role of Balneotherapy in Rehabilitation. J. Barnes Burt.

Practitioner 945:218 (March) 1947.

Balneotherapy is that branch of therapeutics which deals with the use of baths in the treatment of disease. This may be true in some instances, but the general opinion is that a large part of the beneficial effect of baths is due, not to dissolved minerals or radio-activity of the water, but to the physical and thermal action of the baths. In the last twenty years, baths of simple water have been installed for therapeutic use in general hospitals, rheumatic clinics, seaside resorts and mental hospitals. An increasing number of authorities consider that a therapeutic pool is an essential item of equipment in orthopedic centers and departments of physical medicine.

The chief value of baths for the purposes of rehabilitation lies in the physical and thermal action of water on the skin and through the skin on the underlying blood vessels, nerve-endings, sweat glands and muscle; and the elimination of the action of gravity: water, by supporting the weight of the limbs, is an ideal medium for moving stiff and painful limbs.

Balneotherapy is the treatment of disease by the external use of water in the form of baths and douches. Baths are a convenient and easily controlled means of applying external stimuli to the skin and thus affect the nervous system, circulation and metabolism. Therapeutic effects include the relief of pain, relaxation of muscle and absorption of inflammatory products. Types of baths especially useful for purposes of rehabilitation are: (1) the therapeutic pool; (2) aerated immersion; (3) the whirlpool and (4) the contrast bath.

The conditions in which baths are of particular value are: aftertreatment of bone and joint injuries; poliomyelitis, paraplegia and partial paralysis; various rheumatic diseases, and debility following long febrile illness.

Action of Prostigmine on Paralysis Following Cerebral Trauma. N. I. Grashchenkov.

Am. Rev. Soc. Med. 4:201 (Feb.) 1947.

The synthetic drug prostigmine, also known as proserine, is a member of the atropine-antagonist group, almost identical with the natural alkaloid eserine physostigime.

Prostigmine is less toxic and has less effect on the cardiovascular system than natural physostigmine. In other respects the effect of the two alkaloids are similar; both increase intestinal peristalsis and increase the muscarine effect of the cholinergic nerves by inhibiting cholinesterase, assuring a larger accumulation of acetylcholine, the basic mediator of vegetative, sensory, and motor nerves. Both alkaloids lower the blood pressure. Prostigmine is injected in doses of 0.5-1.5 mg.

Clinical trial has given successful results with chemical mediators. In 1936 Walker successfully treated myasthensia with prostigmine, avoiding the toxic effects of physostigmine. The action of prostigmine in myasthenia was explained by deficiency of acetylcholine due to insufficient formation or to excessive destruction of cholinesterase, or by formation of a curare-like substance which paralyzes the myoneural junction. Prostigmine is known to inhibit cholinesterase. In the second explanation, it is assumed to counteract the curare-like substance. At present, the first theory has a greater number of adherents.

Prostigmine was injected one or more times in nearly 300 cases of cerebral trauma with paralysis. In most cases there was immediate and lasting motor and sensory improvement; in some this was striking, and in only 6 per cent of the cases was no improvement observed. The author discusses the possible mechanisms underlying this therapeutic effect, and concludes that prostigmine corrects functional asynapsis — the functional elimination of structurally intact nervous elements exposed to the toxic autolytic products of adjacent destroyed tissue. It is presumed that prostigmine exerts a direct beneficial effect on the altered enzymatic processes in these poisoned tissues, as well as an indirect effect via the vegetative nervous system.